JOINT
CONFERENCE ON
FORESTS AND WATER 2018

05 – 08.11.2018

Proceedings Book 2018

www.forestsandwater2018.cl

Promoting the integration between forest ecosystems, water and society

Objectives

1. Promote science in support of sustainable co-development of forestry (including native forests and plantations), water resources, and aquatic ecosystems in a changing environment.
2. Explore the opportunities and challenges of using the United Nations Agenda 2030 to guide this co-development.
3. Bridge science with society and decision making on forests and water issues in a Latin American context by promoting dialogue.

WELCOME

Dear Forests and Water Professional:

We have been working during the last year to bring together the most knowledgeable researchers from all over the world, as well as leaders in our industry, to explore important topics. For the first time, this conference joins two major series: the Second Latin American Conference on Forests and Water with the Fifth IUFRO Conference on Forests and Water in a Changing Environment.

During the next five days, we will have varied activities including: plenary, technical and poster sessions on cutting edge issues related to our interests. There will also be many opportunities for networking and socializing with colleagues. This joint meeting will help link dynamic developments in Latin American forests to a global community studying environmental change, forests, and water.

The conference is a forum for experts on forest hydrology, watershed ecosystem management, ecohydrology, climate, and environmental change. We hope you will meet new collaborators and gain new ideas for research and action.

Thanks in advance for your participation and we hope that you enjoy the conference.

Regards

Kevin Bishop
Chairman
V IUFRO Conference on Forests and Water in a Changing Environment

Christian Little

Chairman

II Congreso Latinoamericano de Bosques y Agua

Kevin Bishop
Sweden

Christian Little
Chile

Hans Grosse
Chile

Lars Högbom
Sweden

Julia Jones
USA

Antonio Lara
Chile

Ge Sun
USA

Conference Themes:

- T1 The 2030 Agenda framework for forests and waters
- T2 Forest ecosystems, water and climate change adaptation
- T3 Forest certification, government policy and water resources
- T4 Ecosystem service tradeoffs involving water from native forests and plantations
- T5 Aquatic and Riparian Biodiversity – forest ecosystem-stream
- T6 Forests and water: the role of arts, humanities, and communication
- T7 Social aspects of watershed management and monitoring
- T8 Agroforestry and water
- T9 Forest ecosystem restoration for aquatic ecosystem services
- T10 Forests in the food- water-energy nexus
- T11 Modeling and decision support systems linking forest hydrology, mana- gement, and policy

Scientific Committee II Congreso Latinoamericano de Bosques y Agua

Auro Almeida
Common wealth Scientific and Industrial Research Organization (CSIRO), Australia.

Iván Arismendi
Oregon State University, USA.

Patricio Crespo
University of Cuenca, Ecuador.

Silvio Ferraz
Universidade de Sao Paulo, Brazil

Mauricio Galleguillos
University of Chile, Chile.

Pablo Imbach
International Center for Tropical Agriculture (CIAT), Costa Rica.

Andrés Iroumé
Universidad Austral de Chile, Chile.

Esteban Jobbagy
Universidad Nacional de San Luis, Argentina.

Carlos Llerena
Universidad Nacional Agraria La Molina, Perú.

Robert Manson
Institute of Ecology (INECOL), Mexico.

Harry Nelson
University of British Columbia, Canada.

Carlos Oyarzún
Universidad Austral de Chile, Chile.

Catalina Segura
Oregon State University, USA.

Fred Swanson
Pacific Northwest Research Station of the US Forest Service, USA

Juan Camilo Villegas
University of Antioquia, Colombia.

Mauricio Zambrano
Universidad de la Frontera, Chile.

Christian Little
Instituto Forestal, Chile.

Antonio Lara
Universidad Austral de Chile.

Scientific Committee
V IUFRO Conference on Forests and Water in a Changing Environment

Kevin Bishop
Swedish University of Agricultural Sciences
Sweden

Shyue Cherng
Liaw National Taiwan Normal University
Taiwan.

Irena Creed
University of Western Ontario, Canada.

Lars Högbom
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Oregon State University, USA.

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Instituto Forestal, Chile.

Shirong Liu
Chinese Academy of Forestry, China.

Alexander Onuchin
Russian Academy of Sciences, Russia..

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Kyushu University
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Istanbul University, Turkey.

Ge Sun
U.S. Forest Service, USA.

Hyung Tae Choi
National Institute of Forest Science
South Korea.

Adam Wei
University of British Columbia
Canada

Markus Weiler
Institute of Hydrology, Germany.

Zhiqiang Zhang
Beijing Forestry University
China

JOINT CONFERENCE ON FORESTS AND WATER 2018

05 — 08.11.2018

Universidad Austral de Chile

— Valdivia —

PROGRAM

II Congreso
Latinoamericano Bosques y Agua

V IUFRO
Conference on Forests and Water
in a Changing Environment

Irena Creed

University of Western Ontario, Canada

Irena Creed is Executive Director of the School of Environment & Sustainability at the University of Saskatchewan and an ecosystem scientist who studies the impacts of global change on ecosystem structure, function and services.

Juan Pablo Boisier

Universidad de Chile (CR)^2, Chile

Juan Pablo Boisier is a physicist, magister in meteorology and climatology at the University of Chile, PhD in climatic sciences at l'École Polytechnique, France. He is a full time researcher at the Climate and Resilience Science Center (CR)^2. His research area refers to both past and future climate impacts driven by anthropogenic forces on a global scale, with a focus on South America.

Silvio Ferraz

University of São Paulo, Brazil

Silvio Ferraz is Associate Professor at the Department of Forestry Sciences of the Faculty of Agriculture "Luiz de Queiroz" (ESALQ / USP). He is coordinator of the Watershed Monitoring and Modeling Program, with a network of experimental microwatersheds in Brazil and Uruguay. His line of research includes conservation of water resources and aquatic ecosystems in native and non-native forests in the tropical region.

Esteban Jobbagy

Universidad Nacional de San Luis, Argentina (Grupo de Estudios Ambientales)

Esteban Jobbagy a principal research scientist at Argentina's National Scientific and Technical Research Council (CONICET) in San Luis, Argentina. He studies links between vegetation change and hydrology, the effects of deforestation and afforestation on water yield, and groundwater dynamics and salinity in southern South America.

Mingfang Zhang

University of Electronic Science and Technology of China, China

Mingfang Zhang is Head of Department of Environmental Science and Engineering at University of Electronic Science and Technology of China. She studies cumulative effects of forest change on hydrology with a focus on large watersheds in the B.C. Interior of Canada and across various biogeoclimatic zones in China.

Leyend

DAY 1 · Monday 05

Conference Themes

- **T1** The 2030 Agenda framework for forests and waters
- **T2** Forest ecosystems, water and climate change adaptation
- **T3** Forest certification, government policy and water resources
- **T4** Ecosystem service tradeoffs involving water from native forests and plantations
- **T5** Aquatic and Riparian Biodiversity–forest ecosystem-stream connections
- **T6** Forests and water: the role of arts, humanities, and communication
- **T7** Social aspects of watershed management and monitoring
- **T8** Agroforestry and water
- **T9** Forest ecosystem restoration for aquatic ecosystem services
- **T10** Forests in the food-water-energy nexus
- **T11** Modeling and decision support systems linking forest hydrology, management, and policy
- **BT** Blue targeting tool

Conference

- Opening and closing events
- Keynote Sessions
- **IG**nite Presentation
- Poster Session
- Discussions
- **M**oderator
- Coffee break
- Lunch
- Aula Magna room
- Nahmias room

Monday 05

Aula Magna UACh

8:45 – 9:15	Welcome Local Authorities / Choral Presentation
9:15 – 9:25	Welcome Organizing Committee Kevin Bishop - Christian Little
9:25 – 9:55	Irena Creed · Rescaling the Forest-Water Discourse to meet UN Global Goals
9:55 – 10:10	CHANGE FROM PLENARY SESSION TO PARALLEL SESSIONS
10:10 – 10:30	*Coffee break / Nahmias*

	Nahmias 2	Nahmias 3	Nahmias 4
	M Antonio Lara	**M** Julia Jones	**M** Harry Nelson
10:30 – 10:45	**T2:910 · DANIEL NEARY** Climate change, drought, and forest fire interactions - setting the stage for aggravated flooding, water yield decline, and water supply deterioration	**T11:1189 · FELIPE LABRA** Delimitación de zonas de protección de cursos de agua usando herramientas de modelación hidrológica	**T4:958 · LENKA KUGLEROVÁ** How to balance water protection and timber production through novel designs of riparian buffers: A Swedish case study
10:45 – 11:00	**T2:917 · DAVID FONSECA-LUENGO** Effects of land cover change on surface energy balance in the forest in Southern Chile	**T11:1237 · MAURICIO GALLEGUILLOS** Assessment of water yield under global change scenarios in a Mediterranean rainfed watershed dominated by exotic tree plantations	**T4:1005 · KRYSTA GILES-HANSEN** Large-scale forest disturbance and subsequent recovery influence the tradeoff between forest carbon and water services in British Columbia, Canada
11:00 – 11:15	**T2:961 · NATALIIA KOZII** What is the role that trees play in regulating water losses from boreal forested ecosystems?	**T11:1257 · DON WHITE** Parameterising common models of canopy conductance and transpiration for Pinus and Eucalyptus plantations and three important native forest species (Nothofagus glauca, N. obliqua and Cryptocaria alba)	**T4:1089 · KYOICHI OTSUKI** Rainfall partitioning in unmanaged-overstocked dense coniferous plantations with a number of dead branches
11:15 – 11:30	**T2:990 · RAFAEL RUBILAR** Opportunities for improving water sustainability of intensively managed Eucalytpus plantations	**T11:974 · MELISSA PATIÑO** Cambio de uso del suelo y políticas de gestión para la provisión de servicios ecosistémicos relacionados con el recurso hídrico. Un modelo de Dinámica de Sistemas	**T4:1146 · CARLOS GONZÁLEZ** Using Leaf Area Index as a decision variable for optimizing water yield on Pinus radiata plantations in Chile
11:30 – 11:45	**T2:1017 · ANDRÉS IROUMÉ** Decline in catchment runoff with increasing forest age as a function of latitudinal climate differences in Chile and implications for an analogue of climate change impact	**T11:980 · GE SUN** Effects of Wildland Fires on Streamflow in the Contiguous United States	**T4:1221 · CAIO COSTA** Implementing a hydrological monitoring program at Suzano S.A. pulp and paper company
11:45 – 12:00	**T2:1026 · NADEEM SHAH** Significant changes in water quality caused by peatland deforestation and extreme storm events in Scotland	**T2:1095 · ENRIQUE VILLALOBOS VOLPI** Retención de agua en obras de conservación de suelo en zonas áridas y semiáridas	**T4:1232 · LARS HÖGBOM** Payment for Ecosystem Services Forest - Water
12:00 – 12:15	**T2:1020 · O. STRIBLING STUBER** Water use during and after severe drought in a pine-dominated forest: Comparing functional group differences in evapotranspiration		**T4:1304 · CAMILA ÁLVAREZ** The contrasting effects of native forest and forest plantation on catchment water yield

Monday 05

		Nahmias 2	Nahmias 3	Nahmias 4
		M Antonio Lara	**M** Julia Jones	**M** Harry Nelson
		Ignite Presentations		
12:20	12:25	**IGT2:1215 · ANDRÉS IROUMÉ** Analysis of flow variability along a plantation rotation in an experimental catchment in Southern Chile	**IGT3:1000 · BRENDA BRAILLIE** Demonstrating the connection between forests and water values: A review	**IGT9:986 · PAULA MELI** Changes in four hydrological processes under forest alteration and loss
12:27	12:31	**IGT2:1044 · HANG XU** Regulations of Cloudiness on Carbon, Water and Energy Exchanges between a Riparian Poplar Plantation and Atmosphere	**IGT3:1008 · EULALIA BAULENAS** Policy integration between the water and forest sectors across the EU-27: comparison of governance modes and the drivers behind instrument choices	**IGT9:1035 · MARIANE CHITOLINA** A multi-instrumented watershed to estimate the water balance at the Mantiqueira mountains in Extrema, MG/Brasil
12:33	12:38	**IGT2:1092 · VACLAV DAVID** The influence of forests on the runoff from small to medium catchments	**IGT3:1046 · JAMES BATHURST** Field evidence for impact of forest cover and forest management practice on flood peaks	**IGT9:1100 · ZONGSHAN LI** Exploring the effects of the "Grain for Green" program on thedifferences in soil water in the semi-arid Loess Plateau of China
12:40	12:45	**IGT2: 1148 · ROCÍO URRUTIA JALABERT** Assessing the vulnerability of the second longest-lived tree species to a drier climate	**IGT4:972 · MATHEUS OGASAWARA** Effects of forest cover on suspended sediment export in catchments	**IGT9: 1174 · KELLY TONELLO** Analysis Of Hydrological And Structural Indicators On Forest Restoration
13:00	14:30	*Lunch*		
		M Kevin Bishop	**M** Christian Little	**M** Julia Jones
14:30	14:45	**T2:1030 · ADAM WEI** Thinning can mediate the negatively hydrological effects of drought: insight from a young lodgepole pine forest, British Columbia, Canada	**T3:935 · NICHOLAS CLARKE** Forestry intensification as climate mitigation: how is surface water safeguarded?	**T9:1366 · ANTONIO LARA** Progress and Challenges of long-term studies on small watersheds under forest restoration in the Valdivian Rainforest Region of Chile
14:45	15:00	**T2:1041 · ZUOSINAN CHEN** Environmental controls on nocturnal sap flow in Pinus tabuliformis and Acer truncatum forest under different stand ages in northern China	**T3:970 · VICTOR VARGAS** Buenas prácticas de manejo en la gestión forestal de plantaciones forestales en Chile: una evaluación para cuencas proveedoras de agua en la región de Biobío.	**T4:963 · LULU ZHANG** Quantifying ecosystem service tradeoffs resulting from dryland plantation forests for water and food security
15:00	15:15	**T2:1043 · JUAN A. BLANCO** Linkages between large-scale circulation patterns and long-term leaf litter dynamics of Scots pine and European beech mixtures in the Pyrenees	**T3:1069 · DAVID SCOTT** Managing Timber Plantations for Sustained Yields of Clean Water	**T4:981 · TATENDA MAPETO** Closing the forest hydrology loop: A case study of surface water and groundwater interaction within a South African Pine plantation
15:15	15:30	**T2:1045 · ANTONIO DEL CAMPO** ET partitioning in a semiarid coppice forest following scrub clearing and thinning	**T3:1236 · NATHALIA GRANATO LOURES** Compulsory and voluntary mechanisms and water management in plantations	**T2:1076 · ZHIQIANG ZHANG** Streamflow response to the climate change and human activities: from watershed studies to global estimation
15:30	15:45	**T2:1051 · MICHAEL CRAIG** Water and the conservation of wide-ranging Forest Red-tailed Black-Cockatoos in a drying climate	**T3:1159 · ASTRID OPPLIGER** El Nexo entre Ciencia, Politica y Gobernanza en el caso de Escasez de Agua en Plantaciones Forestales en Chile	**T2:1168 · ALEXANDER ONUCHIN** Assessment of the hydrological role of forests in different climatic conditions
15:45	16:00	**T2:1056 · TOMASZ OKRUSZKO** Can we asses fate of forested wetlands under future climate? Case study from Central Europe	**T3:1122 · LENNART HENRIKSON** Blue Targeting: A simple tool for planning of best management practice (BMP) for forestry along small streams	**T8:955 · CONSTANZA BECERRA-RODAS** Bosques nativos ribereños y su rol funcional sobre la regulación de la cantidad y calidad de materia orgánica disuelta en cuencas agroforestales del centro-sur de Chile
		Nahmias		
16:00	16:30	Poster Session (1—25) — Welcome Cocktail		

Leyend

DAY 2 · Tuesday 06

Conference Themes

- **T1** The 2030 Agenda framework for forests and waters
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Conference

- Opening and closing events
- Keynote Sessions
- **IG**nite Presentation
- Poster Session
- Discussions
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- Coffee break
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- Aula Magna room
- Nahmias room

Tuesday 06

Aula Magna UACh

M Julia Jones

8:45 – 9:15 Juan Pablo Biosier · Anthropogenic drying and vegetation changes in central-southern Chile

9:15 – 9:30 CHANGE FROM PLENARY SESSION TO PARALLEL SESSIONS

	Nahmias 2	Nahmias 3	Nahmias 4
	M Linnea Jagrud	**M** Ge Sun	**M** Duncan Christie
9:30 – 9:45	**Blue targeting tool** **ADAM WEI · IUFRO** Introduction	**T7:872 · CLARA MARÍA MINAVERRY** Aportes De La Normativa Y Las Políticas Públicas Vinculadas Con La Protección De Los Servicios Eco-sistémicos. El Caso De Los Recursos Forestales En La Cuenca Del Río Luján, En Argentina	**T1:989 · PAULA MELI** Social perceptions on the forest role on water cycle: implications for forest governance and water-based ecosystem services in tropical countries
9:45 – 10:00	**IUFRO TASK FORCE /GFEP** Forests and Water in a Changing Climate GFEP Report	**T7:889 · RACHEL PRADO** Water PES in watersheds of Brazil: the gaps in socio-economic monitoring	**T1:1039 · DAVID ELLISON** The Forest-Water Divide – Is More Debate Really Necessary?
10:00 – 10:15	**ANNA TENGBERG · SIWI** Swedish Water House's Water and Forest Landscape Multi-stakeholder Platform	**T7:1037 · NELSON JATEL** Water governance networks' influence on water ecological systems over time: An Okanagan valley, Canada case study	**T1:1116 · CRISTIÁN ALARCÓN** The Regional Political Ecology of Forest and Water Use and its Relevance for the Global Development Goals of Agenda 2030: A Comparative Approach to Cases in Chile, Sweden and the US
10:15 – 10:30	**JAMES REED · CIFOR** Landscape Approach in Practice	**T11:1666 · ALAN DE BRITO** Image classification to improve the estimation of GHG emissions through mapping of archetypical vegetation in the savannahs of Brazil.	**T1:1135 · ALAN ABREU** Replanting Life: ecological restoration as a tool for social inclusion and income generation for prisoners
10:30 – 10:45	**ELAINE SPRINGGAY · FAO** Monitoring the Forest and Water Nexus: a new tool platform: Presentation · Interactive Demonstration of the Tool	**T7:1073 · BEVERLEY WEMPLE** Building partnerships for long-term water monitoring in the southern Ecuadorian Andes	**T1:1253 · ISKRA ALEJANDRA ROJO** Evaluación integral de efectos socio- ecosistémicos del Pago por Servicios Ambientales en la Ciudad de México. De los indicadores académicos al monitoreo comunitario
10:45 – 11:00		**T7:1220 · PAULO RODRIGUES** Enhancing forest plantation management based on catchment monitoring program	**T2:1181 · SAMUEL FRANCKE** Conservación de suelos y aguas como mecanismo de adaptación al cambio climático e impactos forestales en la Cuenca Hidrográfica del Río Maule Chile
11:00 – 11:15		**T7:1365 · GIOVANY GUEVARA** The value of citizen science in freshwater research: An example from agricultural small streams in the Colombian Andes	**T4:1363 · DULCE MARIA ROSAS RANGEL** Captación hídrica por escurrimiento cortical de las especies del Bosque Mesófilo de Montaña en Micho-acán, México.
11:15 – 11:45	*Coffee break*		

Tuesday 06

		Blue targeting tool	Ignite Presentations	
11:50	11:55	**LINNEA JAGRUD · SWEDISH FOREST AGENCY** The Blue Targeting Tool	**IGT8:1097 · ENRIQUE VILLALOBOS VOLPI** Modelos agroforestales para la diversificación de las opciones productivas de pequeños propietarios del secano de la región de Coquimbo	**IGT2:1195 · NUZHAT QAZI** Forest Ecosystem Services of Western Himalayan watersheds, India
11:57	12:02	**FAO / SIWI** Moving Forward, Forest/Water Champions, Talanoa Dialogue, COP 21, Input and Dialogue with session participants: What are people doing? What are the opportunities? What are the challenges? Are things missing? Is there a willingness to collaborate? How? What processes/networks or activities can we link up to (including policy processes)?	**IGT11:945 · FRANÇOIS-NICOLAS ROBINNE** Wildfire impacts on hydrologic systems: the state of knowledge in high-latitude forests of North America.	**IGT9:1239 · ENRIQUE CRUZ** Evaluación de la provisión de servicio ecosistémico de provisión de agua bajo escenarios de restauración de bosque nativo para la adaptación al cambio climáticos y su efecto en la producción forestal
12:05	12:09		**IGT11:1129 · TOMÁS MUÑOZ-SALAZAR** Planificación territorial para una gestión integrada de recursos hídricos: caso de estudio zonas de montaña del río Claro de Rengo, Región de O'Higgins	**IGT9:1023 · RENCAI DONG** Exploring the priority area of forest restoration projects in Lugu Lake, China
12:11	12:16		**IGT2:995 · AIMÉ LUCILA IGLESIAS** Establecimiento de especies forestales invasoras en un contexto de cambio climático	**IGT4:1156 · SAMUEL FRANCKE** Análisis comparado de la legislación internacional de sistemas buffer "Zonas de Manejo de Cauce con Énfasis en América Latina y Chile"
12:45	14:30	*Lunch / Lunch Session: IUFRO Task Force on Forests, Soil and Water Interactions*		

		Nahmias 2	Nahmias 3	Nahmias 4
		M Esteban Jobbagy	**M** Mauricio Galleguillos	**M** Mauricio Zambrano
14:30	14:45	**T2:1264 · EMILY CRAMPE** A comparison of convolution and spatially distributed models to estimate mean residence time at the HJ Andrews Experimental Forest	**T8:1094 · BID WEBB** Investigating the impact of trees and hedgerows on landscape hydrology	**T11:953 · FRANÇOIS-NICOLAS ROBINNE** A simple, reproducible model to assess regional-scale community water supply hazard from wildfire
14:45	15:00	**T2:1311 · VIOLETA TOLORZA** Landscape scale erosion after the huge Las Máquinas wildfire in the decennial context	**T8:1298 · BEATRIZ E. MARÍN** Relación del mantillo y la biomasa de raíces con la conductividad hidráulica del suelo en bosques mesófilos secundarios y agroecosistemas cafetaleros en Veracruz, México	**T11:973 · JESSICA SÁNCHEZ LONDOÑO** Adaptation of ECOSER mapping platform to tropical mountain basins in the Colombian Andes: an assessment of forest effects on water-related ecosystem services
15:00	15:15	**T2:1349 · DUNCAN CHRISTIE** Cambios hidroclimáticos y ambientales en el Altiplano sudamericano, pasado y futuro	**T8:1194 · THALIA GUARDIA** Variación del balance hídrico debido a la sustitución de matorral por cultivo frutal en laderas de Chile Central	**T11:991 · LARA GABRIELLE GARCIA** Simulating effects of landscape composition on water availability to downstream water users
15:15	15:30	**T2:962 · KAI SCHWÄRZEL** Partitioning of Evapotranspiration in a multi-layer forest stand in a water scarce region	**T8:1131 · ENRIQUE CRUZ** Impactos de la ganadería y la tala sobre los bosques nativos de conservación y el servicio ecosistémico de calidad de agua a escala de cuenca	**T11:1001 · TREVOR WALTER** Un modelo de análisis espacial multi-criterio para el resguardo ambiental y social en la potencial expansión forestal in Chile
15:30	15:45	**T2:920 · SUSAN QUICK** Woodland waterworlds 3: Resilience to climate change	**T9:1130 · KATHERINE VÁSQUEZ** Hidrología de cuencas de cabecera con bosques en estado inicial: comparación entre vegetación nativa y eucaliptus	**T11:1072 · AURO ALMEIDA** Modelling the effect of vegetation and soil on streamflow at a catchment scale
15:45	16:00	**T2:946 · GUILLERMO BARRIENTOS** The effects of topography and forest management on water storage in catchments in central-southern Chile.	**T2:1054 · MICAHEL RINDERER** Runoff dynamic and nutrient transport under extreme rainfall events in temperate forests - results from large-scale sprinkling	**T11:1133 · JACQUELINE SERRAN** Undisciplinary thinking needed to manage risks to boreal water resources as Canada transitions to a low carbon future
16:00	16:15	CHANGE FROM PARALLEL SESSIONS TO PLENARY SESSION		

		Aula Magna UACh
		M Antonio Lara
16:15	16:45	Silvio Ferraz · Understanding and managing hydrological effects of fast wood plantations in Brazil
16:45	17:15	Esteban Jobbagy · Water cycling in the retreating dry forests of Argentina: News from an unleashed beast
17:15	17:45	*Coffee break*
		M Kevin Bishop
17:45	19:30	Discussion of the IUFRO Global Assessment: Forest and Water on a Changing Planet

Poster Session (26—53)

Field Trips

Option 1 · Puerto Corral and Reserva Costera Valdiviana

Water provision and rainforest ecological restoration processes.

Option 2 · Fitzroya forests

Monitoring of carbon budgets, forest productivity and water balances.

Option 3 · Llancahue — Temperate Valdivian Rainforest

Water supplies and native forest management in a priority site for conservation.

Option 4 · San Pablo de Tregua

Experiment paired watersheds and mixed old-growth forests.

Option 5 · Paillaco – Pichiquema

Rural water management, forest regulation and native forest restoration.

Option 6 · Futa River – BLUE TARGETING TOOL

Designing the riparian buffer zone in forested landscapes.

Leyend

DAY 4 · Thursday 08

Conference Themes

- **T1** The 2030 Agenda framework for forests and waters
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Conference

- Opening and closing events
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- Nahmias room

Thursday 08

Aula Magna UACh

M Kevin Bishop

8:45	9:15	Mingfang Zhang · Think big on forest and water interactions in a changing environment
9:15	9:30	CHANGE FROM PLENARY SESSION TO PARALLEL SESSIONS

		Nahmias 2	Nahmias 3	Nahmias 4
		M Lars Högbom	**M** Antonio Lara	**M** Adam Wei
9:30	9:45	**T5:906 · BRENDA BAILLIE** The impact of an extreme rainfall event on stream and riparian ecosystems and their recovery, in a recently harvested forest in New Zealand	**T2:1099 · LAWRENCE BAND** Forest biodiversity, climate change and urban water supply in the United States southeast	**T2:1065 · SERGIO CONTRERAS** Lacustrine sedimentary leaf wax carbon distribution along a climatological gradient on the western side of the southern Andes
9:45	10:00	**T5:950 · CECÍLIA LEAL** How does disturbance in riparian forests affect Amazonian stream biota?	**T9:1014 · KELLY TONELLO** Native and exotic forest species: similar or different in water use efficiency?	**T2:1113 · SALIM BELYAZID** The zero-sum of climate change on forest ecosystem processes
10:00	10:15	**T5:1219 · FRANCISCO JESUS PEÑAS** Effects of exotic forest plantations on functional and structural indicators of stream health in south-central Chile	**T9:1102 · HAIBIN LIANG** Soil moisture decline following the plantation of Robinia pseudoacacia forests: Evidence from the Loess Plateau	**T2:1150 · JONATHAN BARICHIVICH** Functioning of endangered Fitzroya cupressoides rainforests under drought stress
10:15	10:30	**T5:1227 · JOHN RICHARDSON** Recovery trajectories of streams and riparian areas after forest management	**T9:1123· ALINE FRANSOZI** Recovering soil infiltration capacity along 50 years of natural regeneration on Atlantic forest patches	**T2:1210· FRANCISCA CLEMO** Strong influence of the ocean in the relic forest on semi-arid area of northern Chile; the case Talinay, Fray Jorge National Park
10:30	10:45	**T5:1308· CLAUDIO SOTO-AZAT** Amphibians as indicators of healthy forests	**T9:1157 · ELTON ABEL** Restoration of the hydrological functions on the Ubatiba river watershed in the city of Maricá, Rio de Janeiro, Brazil	**T2:1245 · KEVIN BISHOP** The forest cover – water yield debate: Implications for land management in Ethiopia
10:45	11:00	**T2:1109 · KLAS LUCANDER** Modelling the effects of climate change and nitrogen fertilisation on nitrogen leaching and forest soil organic carbon	**T9:1096 · MARCIA SOUSA DO NASCIMENTO** Management practice's performance in improving infiltration process on areas under active restoration	**T2:1249 · MAURICIO ZAMBRANO-BIGIARINI** Using remote sensing to explore the relationship between the spatial characteristics of Chilean mega-drought and wildfires
11:00	11:15	**T7:1118 · CARLOS LLERENA** Local perceptions of benefits or losses from Eucalyptus and Pine plantations in Cajamarca and Ancash, Peru.	**T9:968 · VIVIEN BONNESOEUR** What do we know about the effects of forestation on soil- and water-related ecosystem services in the Andes?	**T2:1018 · HYUNG TAE CHOI** Assessment of the effect of different thinning intensity on the water cycle of the conifer plantation in South Korea
11:15	11:45	*Coffee break*		

Thursday 08

DAY 4 • Thursday 08

		Nahmias 2	Nahmias 3	Nahmias 4
		Ignite Presentations		
		M Julia Jones	**M** Antonio Lara	**M** Adam Wei
11:50	11:55	**IGT5: 1104 · DANIELA NUÑEZ** Respuestas de macroinvertebrados al establecimiento de una mini central hidroeléctrica	**IGT6:1203 · RICHARD HALL** Forrest Gump and Reflections on a Forested Coastal Landscape in Alabama	**IGT2:1289 · JULIA JONES** Summer streamflow deficits from regenerating Douglas-fir forest in the Pacific Northwest, USA
11:57	12:02	**IGT5:1364 · GIOVANY GUEVARA** Hydrobiology and biogeochemistry in headwater streams of southern Chile: Effect of forest management	**IGT6:1306 · RAQUEL ROMERO** Árboles viejos, retoños y semillas: Las voces de los campesinos del bosque nublado	**IGT2:1303 · FRANCISCO BALOCCHI** Water balance of catchments covered with Pinus radiata and Native Forest before and after the fires of Jan 2017
12:05	12:09	**IGT5:1255 · ISKRA ALEJANDRA ROJO** Biodiversidad de flora y fauna asociada a los cuerpos de agua superficiales, su calidad y su cantidad en Suelo de Conservación de la Ciudad de México, México	**IGT11:1347 · FERNANDO GIMEN** Evaluación de la respuesta hidrológica bajo distintos escenarios de cobertura de suelo en la cuenca del río Lumaco, Chile	**IGT2:1270 · MIGUEL ANGEL LARA GOMEZ** Cuantificación de errores asociados al diseño de un inventario LiDAR en una plantación de Pinus radiata en Chile
12:11	12:16	**IGT10:1214 · ADEGBITE ADELEKE ADESIPO** Impact of mining on the floristic association of gold mined sites in Southwest Nigeria	**IGT8:905 · CLARA MARÍA MINAVERRY** El Valor Del Estudio Y Aplicación De Normas Obligatorias Y Voluntarias En La Protección De Los Ecosistemas "Bosque – Agua" A Través Un Enfoque Interdisciplinario "	**IGT2:1274 · GUILLERMO PALACIOS** Estudio de la tipificación del Miombo en la provincia de Huambo (Angola) a través del uso de imágenes de media y alta resolución
12:45	14:30	*Lunch*		
		M Paula Meli	**M** Ge Sun	**M** Fred Swanson
14:30	14:45	**T5:1055 · LUIS URIBE** Biodiversidad taxonómica y funcional de macroinvertebrados en arroyos de cuencas intactas e impactadas de la Región de Aysén	**T9:1354 · JULIA JONES** Water scarcity: fish, forests, people, agriculture – a case study from semi-arid southeast Washington, United States	**T7:1284 · CHRISTIAN LITTLE** Priorizando áreas para recuperar bosques nativos en el centro sur de Chile: un enfoque a partir de la provisión de agua como un servicio que prestan las cuencas forestales
14:45	15:00	**T5:1108 · ANNA ASTORGA** Temperate forests as ecosystem references from the watershed perspective in Southern Chile	**T9:969 · LAURA VICTORIA CANO ARBOLEDA** Evaluating ecohydrological function of tree species in ecological restoration projects through their functional traits	**T7:1052 · MARCOS KARLIN** Cambios en el uso del suelo: ¿cómo alteran las tasas de infiltración en el centro de argentina?
15:00	15:15	**T5:1302 · RAQUEL ROMERO** Rol de las bromelias en la captura de agua de niebla, el flujo de materia orgánica y nutrientes en un bosque nublado en Colombia	**T9:1022 · JI QI** Longleaf Pine Restoration for Streamflow in the Lower Flint River	**T4:1088 · SEONGHUN JEONG** Stand-scale estimation of throughfall and stemflow for Japanese coniferous plantations
15:15	15:30	**T10:997 · STEVEN BRANTLEY** Frequent-fire conifer forests of North America: Understanding trade-offs between water yield and carbon sequestration	**T9:992 · SILVIO FERRAZ (GLÁUCIA SANTOS)** Aquatic Litter Decomposition In Riparian Vegetation Under The Influence Of Eucalyptus Trees	**T2:1111 · SANTIAGO VALENCIA CÁRDENAS** Effects of environmental change on water availability of a tropical mountain watershed in Colombiat
15:30	15:45	**T10:1064 CECILIA AKSELSSON** Trade-offs between bioenergy extraction in boreal forests and soil and water quality: A dynamic modelling study in long-term experiments	**T9:1093 · RATKO RISTIĆ** Hydrological effects of forest vegetation in watershed restoration in serbia	**T4:1369 · ALBERTO GOMEZ-TAGLE** Hydrological impact of the green gold (avocado culture) in central Mexico; rainfall partition and water use comparison with native forest
15:45	16:00	CHANGE FROM PARALLEL SESSIONS TO PLENARY SESSION		
		Aula Magna UACh		
		M Julia Jones		
16:00	17:00	Final Discussion and Conclusion		
17:00	17:30	CHANGE FROM PARALLEL SESSIONS TO MAC (CONTEMPORARY ART MUSEUM) HTTPS://VIMEO.COM/216903063		
17:30	20:00	Cocktail and artistic event		

ABSTRACTS

ABSTRACT INDEX BY TYPE

ORALS ---------- 17

IGNITE ---------- 106

POSTERS ---------- 133

TABLE OF CONTEST
ORAL AND IGNITE ABSTRACT BY ID NUMBER

Abel, E .; 1157(T9)
Abreu,A .; 1135 (T1)
Adeleke, A.; 1214(T10)
Akselsson, C.;1064 (T10)
Alarcon, C.; 1116 (T1)
Almeida, A .; 1072 (11)
Alvarez, C.; 1304 (T4)
Astorga, A., 1108(T5)
Baillie , B.; 906(T5), 1000(T3)
Balocchi, F .; 1303 (T2)
Band, L .; 1099(T2)
Barichivich, J.; 1150(T2)
Barrientos, G.; 946 (T2)
Bathurst,J .; 1046(T3)
Baulenas, E .; 1008(T3)
Becerra, C .; 955 (T8)
Belyazid, S.; 1113(T2)
Bishop, K.; 1245 (T2)
Blanco, J.; 1043(T2)
BONNESOEUR, V.; 968 (T9)
Brantley, S.; 997 (T10)
Campo , A.; 1045(T2)
Cano Arboleda, L.; 969(T9)
Chen, Z.; 1041(T2)
Cherng Liaw, S.; 1048(T7)
Chitolina, M .; 1035 (T9)
Clarke, N.; 935(T3)
Clemo, F.,1210 (T2)
Contreras, S.; 1065 (T2)
Costa, C.; 1221(T4)
Craig, M.;1051(T2)
Crampe, E.; 1264 (T2)
Cruz, E.; 1131(T8), 1329(T9)
Dong, R.; 1023(T9)
Duncan, C.; 1349(T2)
Ellison, D.;1039 (T1)
Fonseca-Luengo, D.; 1039(T1)
Francke, S.; 1156(T4), 1181(T2)
Fransozi, A.; 1123 (T9)
Galleguillos, M.; 1237 (T11)
Garcia, L.; 991(T11)
Giles, K.; 1005 (T4)
Gimeno, F.; 1347 (T11)
Gomez-Tagle, A.; 1369(T4)
Gonzalez, C .; 1146 (T4)
Granato, N .; 1236 (T3)
Guardia, T.; 1194(T8)
Guevara, G.; 945(T11), 953(T11)
Hall, R .; 1203(T6)
Henrikson, L .;1122 (T11)
Högbom, L.; 1232(T11)
Iglesias, A.; 995(T1)
IROUME, A.; 1015(T2),1017(T2)
Jatel, N .; 1037(T7)
JEONG, S.; 1088(T4)
Jones, J.; 1289(T2), 1354 (T9)
Karlin, M.; 1052 (T7)
Kozii, K.; 961 (T2)
Kuglerová, L.; 958(T4)
Labra, F.; 1189(T11)
Lara , A.; 1366 (T9)
Lara, M.; 1270 (T2)
Leal, C.; 950(T5)
li, Z.; 1100 (T9)
liang, H .; 1102 (T9)
Little, c.; 1284(T7)
Llerena, C .; 1118 (T7)
Mapeto, T.; 981(T4)
Marín, B.; 1298 (T8)
Meli, P.; 986(T9), 989(T1)
Minaverry, C.; 872 (T7), 905(T8)
Muñoz, T.; 1229(T11)
Neary, D.; 910(T2)
Nuñez, T., 1104(T5)
Ogasawara, M.; 972 (T4)
Okruszko, T .; 1056 (T2)
Onuchin, A .; 1168(T2)
Oppliger, A.; 1159 (T3)

Otsuki, K.; 1089 (T4)
Palacios, G.;1274(T2)
Patiño, M .;974 (T11)
Peñas, F .; 1219(T5)
Prado, R.; 889(T7)
Qazi, N.; 1195(T2)
Qi, J.; 1022(T9)
Quick, S.; 920(T2)
RICHARDSON, J.; 1227(T5)
Ristić, R .; 1093 (T9)
Robinne, F.; 945(T11), 953(11)
Rodrigues, P.; 1220(T7)
Rojo, I .; 1253(T1), 1255(T5)
Romero, M.; 1302(T5), 1306(T6)
ROSAS, D.; 1363 (T4)
Rubilar, R.;990(T2)
Sánchez, J .; 973 (T11)
Santos, G.;922(T9)
Schwärzel, K.; 962(T2)
Scott, D.; 1069(T3)
Serran, J.; 1133(T11)
Shah, N.; 1026(T2)
Soto-Azat, C.; 1308(T5)
Sousa, M.; 1096(T9)
Stuber, S .; 1020(T2)
Sun, G.; 980 (T11)
Tae Choi, T.; 1018(T2)
Tolorza, V.; 1311(T2)
Tonello, K .; 1014 (T9), 1177 (T9)
Uribe, L.; 1055(T5)
Urrutia, R.; 1148 (T2)
Vaclav, D .; 1092 (T2)
Valencia, S.; 1111 (T2)
Vargas, V.; 970(T3)
Vásquez, K.; 1130(T9)
Villalobos, E .; 1095(T2), 1097(T8)
Walter, T .; 1001(T11)
Webb, B.; 1094 (T8)
Wei, A.; 1030 (T2)
Weiler, M.; 1054 (T2)
Wemple, B.; 1073 (T7)
White, D.; 1257(T11)
Xu, H.; 1044 (T2)
Zambrano-Bigiarini, M.;
Zambrano-Bigiarini, M.; 1249(T2)
Zhang, L.; 963(T4)
Zhang, Z.; 1076(T2)

ORALS

ID 872

APORTES DE LA NORMATIVA Y LAS POLÍTICAS PÚBLICAS VINCULADAS CON LA PROTECCIÓN DE LOS SERVICIOS ECOSISTÉMICOS. EL CASO DE LOS RECURSOS FORESTALES EN LA CUENCA DEL RÍO LUJÁN, EN ARGENTINA

Prof. Clara María Minaverry [1 2 3], Dr. Mariano Ferro[4 5] , Dr. Clara María Minaverry[6] ,
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La complejidad de la actividad industrial y la urbanización no planificada han dado origen a una situación crítica de contaminación, y el creciente agotamiento o deterioro de los acuíferos. El caso de la contaminación de los cursos de agua en la Región Metropolitana del Gran Buenos Aires representa el problema ambiental urbano más grave en el nivel nacional. La expansión del entramando urbano en la Provincia de Buenos Aires y de la industria agropecuaria en la áreas rurales, ha implicado la desaparición o la profunda alteración de los ecosistemas originarios. Desde la introducción del paradigma ambiental a la Constitución reformada en 1994 en Argentina se abrigaron grandes expectativas de superación del enfoque convencional, de tipo sectorial y fragmentado. En el caso de las áreas urbanas, la adopción de nuevos enfoques como el de la Gestión Integrada de los Recursos Hídricos conlleva la complejidad de integrar los complejos sistemas políticos y socio-legales con los sistemas naturales. El reciente enfoque ecosistémico añade mayor complejidad porque nos introduce a la necesidad de conjugar el nivel de la gestión de la cuenca con el de los ecosistemas. En este trabajo analizamos el nivel de efectividad de la normativa y de las políticas públicas vinculadas con la protección de los servicios ecosistémicos en una de las cuencas Metropolitanas del Gran Buenos Aires: la Cuenca del Río Luján. Se recurre a la estrategia de la triangulación metodológica: la realización de entrevistas a expertos e informantes clave; el análisis de documentos públicos; análisis de medios gráficos de circulación nacional y la hermenéutica jurídica. Podemos concluir que es imprescindible la necesidad de coordinación entre los diversos niveles, incluyendo el internacional, así como la conjunción entre la gestión en el nivel de la cuenca hidrográfica y en el nivel de los ecosistemas.

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ID 889
WATER PES IN WATERSHEDS OF BRAZIL: THE GAPS IN SOCIOECONOMIC MONITORING

Dr. Rachel Prado[1], Other Ana Paula Moraes de Lima[2], Dr. Rachel Bardy Prado[3], Dr. Agnieszka Ewa Latawiec[4]
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Hydrological ecosystem services are defined as the benefits offered by freshwater and terrestrial ecosystems, which include fresh water supply, water quality regulation, flood mitigation, erosion control, and water-related cultural services. As a way to mitigate negative impacts in the hydrological ecosystem and encourage conservation, methods of financial compensation to farms have been applied around the world. Up to mid-2009 there were about 150 Payment for Ecosystem Services (PES) initiatives in Latin America, operating approximately in 2.5 million hectares. In Brazil, the most well-known water PES is the Water Producer Program of the National Water Agency (ANA). It stimulates the implementation of water PES projects in the strategic basins for restoration and water supply. This study investigated the main water PES in progress in Brazil, evaluating the situation of its monitoring, especially under the socioeconomic aspects. Data were collected from the literature, as well as an interview with actors related to the monitoring of the 6 water PES (Water Conservative – MG, Oásis Brumadinho – MG, Water Producer Camboriú – SC, Water Producer Pipiripau – DF, Water and Forest Producers Guandu – RJ). It was obtained that socioeconomic water PES monitoring in Brazil is scarce and sometimes non-existent. Where they exist the frequency and method are not well defined. Of 70 indicators identified for the monitoring, 61% were related to ecosystem services (physical-chemical conditions of the environment), 23% of evaluated the structure or interventions and only 16% related to socioeconomic aspects (seeking to assess the benefits of the community). This may be a reflection of the fragmented and dichotomous way that science has dealt with environmental issues, separating man and nature in their studies and projects. But, interviewees recognize the importance of socioeconomic water PES monitoring in Brazil and report that there was a progress in the implementation of them.

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ID 906

THE IMPACT OF AN EXTREME RAINFALL EVENT ON STREAM AND RIPARIAN ECOSYSTEMS AND THEIR RECOVERY, IN A RECENTLY HARVESTED FOREST IN NEW ZEALAND

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Hydrological ecosystem services are defined as the benefits offered by freshwater and terrestrial ecosystems, which include fresh water supply, water quality regulation, flood mitigation, erosion control, and water-related cultural services. As a way to mitigate negative impacts in the hydrological ecosystem and encourage conservation, methods of financial compensation to farms have been applied around the world. Up to mid-2009 there were about 150 Payment for Ecosystem Services (PES) initiatives in Latin America, operating approximately in 2.5 million hectares. In Brazil, the most well-known water PES is the Water Producer Program of the National Water Agency (ANA). It stimulates the implementation of water PES projects in the strategic basins for restoration and water supply. This study investigated the main water PES in progress in Brazil, evaluating the situation of its monitoring, especially under the socioeconomic aspects. Data were collected from the literature, as well as an interview with actors related to the monitoring of the 6 water PES (Water Conservative – MG, Oásis Brumadinho – MG, Water Producer Camboriú – SC, Water Producer Pipiripau – DF, Water and Forest Producers Guandu – RJ). It was obtained that socioeconomic water PES monitoring in Brazil is scarce and sometimes non-existent. Where they exist the frequency and method are not well defined. Of 70 indicators identified for the monitoring, 61% were related to ecosystem services (physical-chemical conditions of the environment), 23% of evaluated the structure or interventions and only 16% related to socioeconomic aspects (seeking to assess the benefits of the community). This may be a reflection of the fragmented and dichotomous way that science has dealt with environmental issues, separating man and nature in their studies and projects. But, interviewees recognize the importance of socioeconomic water PES monitoring in Brazil and report that there was a progress in the implementation of them.

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ID 910

CLIMATE CHANGE, DROUGHT, AND FOREST FIRE INTERACTIONS - SETTING THE STAGE FOR AGGRAVATED FLOODING, WATER YIELD DECLINE, AND WATER SUPPLY DETERIORATION

Dr. Daniel Neary[1], Dr. Pablo Garcia-Chevesich [2], Dr. Alejandro Leon[2], Dr. Roberto Pizarro [3]
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Changing climates in some forested regions of the world are increasing temperatures and decreasing rainfall. The resulting increase in drought conditions are impacting regions such as Australia, Indonesia, Canada, the USA, Chile, Portugal, Spain, Israel, and Russia, among others. This phenomenon has led to increased fire season length and severity. For instance, in the western USA the wildfire season is now 105 days longer than several decades ago. The incidence of high severity wildfires is increasing and area coverages are also greater. High severity fires are altering the hydrologic function of forest ecosystems and their soils leading to increased post-fire flooding. Hydrologic function changes include loss of the forest floor organic layers, increased rill and gully erosion, decreased Ksat and soil's water infiltration, and erosional losses of well-structured soil horizons. Increased runoff from fire-impaired soils is aggravating flooding, deteriorating water quality, and decreasing the amount of water infiltrated and stored in the soil and subsurface geologic formations. The latter process has the potential to decrease long-term water yield for municipal water supplies. Flooding also puts municipal water supplies at risk from sediment deposits in reservoirs and physical damage to water supply infrastructure. Chile was affected by droughts and severe wildfires in 2017 that burned vast territories planted with pines and eucalyptus. This happened because of high temperatures, long term drought, and areas planted in one continuous species of trees.This paper examines the chain of catchment disturbance events initiated by changes occurring in the climate and examines what can be done by land management to alter the course of events and mitigate impacts.

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ID 917
EFFECTS OF LAND COVER CHANGE ON SURFACE ENERGY BALANCE IN THE FOREST IN SOUTHERN CHILE

Dr. David Fonseca-Luengo[1]
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The surface energy balance (SEB) is the key factor that drive different responses on the Earth. In the agriculture, the SEB is studied because this can be related with the water consumption of the crop, through the evapotranspiration. Also, the SEB can explain the increase in air temperature due to the change of land cover, since different kind of surface can use less energy in internal process and release more energy to the environmental, in form of temperature, being this change in land cover a contribution to the warm effect from the climate change. In a more extensive sense, the SEB model can to explain the redistribution of the energy in heat and moisture fluxes between the soil and the atmosphere. Following this idea, the SEB model is presented as a useful tool to describe the Earth behavior facing changes in the land cover/use. From this perspective, the native forest response to the climate change and anthropogenic effects is an interesting analysis for different areas, such as environmental and hydrological modeling. In this sense, in the present study we analyzed the multi-seasonal SEB components for different native forests of the Southern Andes in the Región de la Araucanía, Chile, aiming to find relations between the land cover change and energy/water fluxes from the surface. The SEB maps were generated considering the METRIC (Mapping Evapotranspiration at High Resolution) model, which is one the most used method to generate the SEB components with spatial and temporal distribution, using Landsat-7/8 images and ground data from a weather station.

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ID 920
WOODLAND WATERWORLDS 3: RESILIENCE TO CLIMATE CHANGE

Mrs. Susan Quick[1], Prof. A.R. MacKenzie[1], Prof. Stefan Krause[1], Prof. A.R. MacKenzie[1]
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Water is essential to life on Earth; water abundance in a place, and water requirements of living things, are controlled ultimately by weather and climate. Under climate change, by 2050 say, increased temperatures, atmospheric carbon dioxide (CO2)/ greenhouse gas content and more extreme weather systems are predicted. Trees are long-lived organisms. In a changing climate they mature in conditions very different from those during germination. Whilst climate zones and topography provide 'natural laboratories' to study changing temperature and

water availability, there are very few natural laboratory options like Birmingham Institute of Forest Research (BIFoR) Free-Air CO2 Enrichment (FACE) facility for studying the impact of changes to global atmospheric composition. This project, at BIFoR FACE situated in a native temperate mature mixed broadleaf oak-hazel woodland in Staffordshire UK, investigates the role of water and water vapour, cycling through vegetation, the soil and the atmospheric interface in ecosystem patches at ambient and elevated CO2. To characterise the woodland, the study focuses initially on how the dominant species pedunculate oak (Quercus robur) adapts; subdominant tree species such as sycamore (Acer pseudoplatanus) may differ in response and will also be considered. The part-time study, until at least 2020, uses direct observations, and remote measures (e.g. of soil moisture and sap-flow) to see how tree-soil-water interfaces behave and change with increased CO2. Measurements were selected by considering carbon, energy and water exchange: inputs-outputs (e.g. precipitation), waterflow (e.g. sapflow), temperature and radiation. Early stage results are presented from years 1-2 (2017-2018) of the CO2 enrichment to determine initial trends. This evaluation of water system dynamics can assist in interpretation of forest microclimatic effects across the BIFoR FACE forest stand and could help predict whether natural woodland ecosystems can adapt and stay resilient under future climate conditions.

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ID 935
FORESTRY INTENSIFICATION AS CLIMATE MITIGATION: HOW IS SURFACE WATER SAFEGUARDED?

Dr. Nicholas Clarke[1], Dr. Frode Sundnes[2], Dr. Marianne Karlsson[2], Dr. Froukje Platjouw[2], Dr. Salar Valinia[3], Dr. Øyvind Kaste[3]
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[3] Norwegian Institute for Water Research – NORWAY

The Norwegian government launched a series of measures in 2015 to intensify forestry for mitigation of climate change. These measures involved government support to afforestation of new areas in selected regions, densification of existing forests, and forest fertilisation. Based on a review of laws, regulations and policy documents, and interviews with key actors in the implementation of these measures, we try in this paper to assess whether water is satisfactorily safeguarded in these climate mitigation efforts. While concerns about water quality do enter the authorities' justification for these measures, we see that forestry and surface waters are to a large extent treated as separate domains in policies and regulations, both nationally and internationally. We do however find that a number of safeguards are in place to minimize the effects of forestry measures on water resources, but that there are also a number of weaknesses in the existing regulation and approach taken. Forest cooperatives have a strong role in making sure that the industry

standard is adhered to, but there are indications that existing arrangements for reporting and control are inadequate. We also see that there is a need for clarity on sanctions against forest owners, cooperatives and municipalities when regulations are not complied with. The quality of existing maps and datasets for environmental values has also been questioned. Overall we do identify a challenge in separating the impacts of the climate mitigation measures in forestry from the impact of the forestry industry in general. Considering the current extent of forest intensification in Norway, there seems to be a higher degree of uncertainty with regard to the climate effects of the forestry intensification measures than there is with regard to immediate impacts on water quality. Further research on the longer term impacts of such intensification measures is however called for.

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ID 946

THE EFFECTS OF TOPOGRAPHY AND FOREST MANAGEMENT ON WATER STORAGE IN CATCHMENTS IN CENTRAL-SOUTHERN CHILE.

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ABSTRACT Our work analyzes the variability of the volume of water stored in fifteen forested headwater catchments from central-southern Chile, between individual hydrologic years. Our aim is to understand how forest management, hydrology, and climate influence the dynamic components of catchment storage. To this end we addressed the following questions: (i) How does annual water storage vary in catchments located in diverse hydroclimate conditions and subject to variable forest management? And, (ii) What natural (i.e. hydrologic regime and physiography setting) and anthropogenic factors explain the variance in water storage? Our results show that annual catchment storage increases at the beginning of each hydrological year in directly response to increases in rainfall. Maximum water storage ranged from 666 - 1272 mm in these catchments. Catchments with Pinus or Eucalyptus spp. Stored less water than catchments with mixed forest species cover. Forest cover (biomass volume, plantation density, percentage of plantation and age) was the primary controls of dynamic storage in the catchments. These results indicate that forest management may alter catchment water storage. *Corresponding author: Guillermo Barrientos, Graduate School, Universidad Austral de Chile, Faculty of Forest Sciences and Natural Resources, Independencia 631, 5110566 Valdivia, Chile. Tel.: +56-63-2293004; E-mail address: guillermo.barrientos@alumnos.uach.cl.

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ID 950

HOW DOES DISTURBANCE IN RIPARIAN FORESTS AFFECT AMAZONIAN STREAM BIOTA?

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Riparian forests are the primary interface between aquatic and terrestrial ecosystems in low-order tropical streams. They constitute important sources of nutrients and organic matter to the aquatic fauna, provide structures such as large wood that influence the structural complexity of streams and regulate the terrestrial runoff while maintaining water quality. Nevertheless, different freshwater biotic groups might respond to anthropogenic changes in the riparian vegetation in different ways. Here we investigate if responses to riparian disturbance are congruent between various groups of the Amazonian aquatic fauna. We studied 99 low-order stream sites occurring in three river basins in two large Brazilian municipalities (Santarém and Paragominas) incorporating a diverse mosaic of land uses in the human-modified eastern Amazon. We used high resolution satellite images to assess landscape anthropogenic disturbances at the riparian vegetation. We collected a total of 143 fish species, 134 Odonata species, 50 Gerromorpha species, and 59 EPT (Ephemeroptera, Plecoptera and Trichoptera) genera. We found mixed responses from the aquatic biota regarding the influence of riparian disturbances. Riparian forest cover was a major driver of dragonfly assemblage structure but less so for the other aquatic groups. Our historical land use indicators measured at the riparian zone (i.e. historical deforestation pattern and time since deforestation) accounted for a small variation in fish assemblages. Gerromorpha and EPT showed positive relationship with our index of proximity of human impact. Overall, our findings underscore the complexity of the relationships between aquatic biota and riparian zones in species-rich tropical ecosystems. Riparian management focussing on single biotic groups might fail to represent other groups. Moreover, it is crucial to consider a wide range of disturbances of the riparian zone, which can give complementary information. We draw on the relationships observed in our data to suggest priorities for improved management of stream systems in human-modified Amazonian landscapes.

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ID 953

A SIMPLE, REPRODUCIBLE MODEL TO ASSESS REGIONAL-SCALE COMMUNITY WATER SUPPLY HAZARD FROM WILDFIRE

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A multitude of extreme wildfire events has shed light on the vulnerability of societies to catastrophic changes in their watersheds. Wildfires present a range of potential water risks to the hydrology and morphology in upstream, burned forests. Such perturbations can impair the provision of water-related ecosystem services coming from forested watersheds and threaten the reliability of downstream water supplies for social and ecological needs. Assessing post-fire threats to water resources through time and space is complex. We argue that development of models using the growing availability of datasets and computing power is likely to provide critical insights necessary to assess threats and develop sustainable land and water management and policy strategies. However, there is a risk for model complexity to hinder the translation of cutting-edge scientific results into management or policy. Several case studies have illustrated the importance of simplicity of scientific outcomes for their adoption in the decision-making process. We provide an example where we adapted a simple spatial model to assess regional-scale exposure of surface-water resources to wildfire activity at the provincial (state) scale in Alberta, Canada. The model relies on four variables depicting water availability, forest cover, downstream population, and fire hazard. The result provides an index of water resource exposure to wildfire (0–100) per watershed. Although only providing a broad-scale picture of potential post-fire water risks, the model can help to focus land and water governance policies on the most vulnerable regions. It can also help to identify individual watersheds where more complex risk analysis should be performed. Such decision-support tools use simple logic and available datasets, making it relatively easy to deploy elsewhere. With growing threats from global environmental change, such simple tools can also help quickly test projected

environmental conditions, thereby supporting more rapid land and water management adaptation.

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ID 955

BOSQUES NATIVOS RIBEREÑOS Y SU ROL FUNCIONAL SOBRE LA REGULACIÓN DE LA CANTIDAD Y CALIDAD DE MATERIA ORGÁNICA DISUELTA EN CUENCAS AGROFORESTALES DEL CENTRO-SUR DE CHILE

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La presencia de bosques nativos aledaños a los cursos de agua (BNR) tiene un rol clave en la conservación del agua en cantidad y calidad, por lo que comúnmente son denominados como filtros contra contaminantes. Además, son importantes reguladores en el ciclo de la materia orgánica disuelta (MOD) en el agua, específicamente en el ingreso de detritus alóctono a los cauces. En el centro-sur de Chile, donde se concentra la actividad agroforestal, estos BNR han sido degradados o sustituidos por otros usos de suelo, influyendo en características de MOD. Seleccionando como modelo de estudio 11 cuencas pequeñas dominadas por bosques nativos, plantaciones de especies exóticas y terrenos agropecuarios, evaluamos el rol funcional de los BNR mediante la MOD, en sus diversas formas, como un indicador de la biogeoquímica y calidad del agua. Utilizando modelos de regresión múltiple y la incorporación de usos de suelos a escala ribereña y cuenca, explicamos la variabilidad de la MOD en las diferentes cuencas. Las concentraciones de carbono inorgánico disuelto (CID), relación COD:CID y componentes fluorescentes están en función de la cobertura de BNR. En cuencas agroforestales, el incremento en cobertura de BNR se relaciona entre 40-70% con la cantidad y la calidad de la MOD, específicamente bajos valores de CID y una mayor proporción de componentes similar ácidos húmicos. Esto evidencia que los BNR aportan detritus de lenta descomposición, por ende, de menor procesamiento, respiración y mineralización del carbono y un mayor transporte aguas debajo de MOD, influyendo sobre la integridad funcional y calidad de agua en cuencas agroforestales. Estrategias de manejo integral de cuencas y budgets de carbono en sistemas terrestre-acuático-atmósfera deberían incorporar este rol funcional de los BNR. Métricas asociadas a MOD son herramientas en la identificación de áreas prioritarias para la restauración de BNR y la recuperación de sus servicios ecosistémicos.

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ID 958

HOW TO BALANCE WATER PROTECTION AND TIMBER PRODUCTION THROUGH NOVEL DESIGNS OF RIPARIAN BUFFERS: A SWEDISH CASE STUDY

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The importance of riparian forests for stream water quality and quantity, biodiversity and ecosystem functioning has been recognized for decades and thus remaining trees are often left as buffers during harvest operations. In many countries, riparian buffers are usually allocated to larger streams and rivers while small headwaters receive the least protection (thin or completely missing buffers). However, headwaters are most vulnerable to forestry operations reacting abruptly to canopy removal by e.g., increased water temperature, nutrient and sediment levels, and changed hydrology and biodiversity. Headwater impairments are also carried downstream causing cumulative effects in larger waterbodies. It is becoming increasingly evident that compromising riparian buffers along the smallest streams has incurred enormous expenses to restore downstream areas. At the same time, it is clear that retaining riparian buffers around all waterbodies, large and small, imposes a severe economic pressure. In this project we investigate the options of how to balance economic and environmental goals through novel designs of riparian buffers along headwaters in the Swedish landscape. First, we assessed contemporary riparian buffer practices through large-scale field surveys. This investigation revealed that despite the many recommendations for retaining riparian buffers along small streams, imposed by the Swedish Forest Agency, buffers are rarely left > 5 m wide. This is likely motivated by the commercial value of timber and inadequate mapping of small streams as well as lack of knowledge among forest owners about the importance of source areas. We continue to investigate the hydrological, biogeochemical and ecological role of buffer zones on receiving aquatic ecosystems. Based on our findings, we suggest that functional riparian buffers should be of variable widths, forest age structure and composition across small spatial scale. We further present some novel tools for buffer delineation in order to help decision-makers to satisfy both industry and environmental needs.

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ID 961

WHAT IS THE ROLE THAT TREES PLAY IN REGULATING WATER LOSSES FROM BOREAL FORESTED ECOSYSTEMS?

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The flow of water vapour from terrestrial ecosystems to the atmosphere is often treated as a uniform flux called evapotranspiration (ET). However, ET consists of two fundamentally different pathways: (1) evaporation from wet surfaces and (2) transpiration through stomata of plants, and likely respond differently to climate change and forest management practices. To get a deep understanding of the driving mechanisms and quantities of vertical water losses from forested ecosystems, we separated ET into physiologically driven tree transpiration (T), physically driven evaporation from canopy intercepted water (CI), and combined flux from understory vegetation and soils (ETu). This study was conducted in a boreal catchment in northern Sweden, which represents a region that is projected to experience higher rate of climate change compare to global trend. In this presentation, we will quantify the amount of water lost to the atmosphere through T, CI, and ETu during the growing season and compare these amounts to other water budget components (i.e., precipitation and stream runoff). Additionally, we will describe temporal variation in different water loss pathways and their environmental controls. Our results are based on empirical measurements of T using Granier-type sap flow sensors, event-based estimates of CI with throughfall gauges, ET flux measurements using the eddy covariance technique, and continuous measurements of precipitation and stream runoff. High-resolution airborne LIDAR data are used to scale up the plot measurements to the catchment scale. Together with the empirical measurements, we used a soil-vegetation-atmosphere transfer model (APES) to provide a mechanistic understanding of different water loss pathways and their drivers in boreal forest ecosystems. We will discuss the results in the context of identifying sustainable forest management practices in a changing future climate.

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ID 962

PARTITIONING OF EVAPOTRANSPIRATION IN A MULTI-LAYER FOREST STAND IN A WATER SCARCE REGION

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Research has shown that unmanaged, dense forest stands in water-limited regions escalate water shortage due to high water consumption of such forest covers. Forest evapotranspiration is composed of several components, such as the canopy and litter interception, understory and overstory transpiration, and soil evaporation. The relative contribution of these components to total evapotranspiration depends on the forest structure. Any management induced changes in forest structure will thus result in a different relative contribution of these components to total evapotranspiration. As a consequence, such changes in evapotranspiration will also lead to a complex change in water yield. Thus, a better understanding of how the forest structure controls partitioning of evaporative fluxes into its individual components will be the key for the development of a more water-saving forest management in water-limited environments. The study took place in China's Loess plateau region. In that region, black locust plays a major role in China's large-scale afforestation programs. These programs aim to control desertification and soil erosion but contributed to the increasing regional water scarcity. In our study, evaporative fluxes of a black locust plantation with understory were partitioned into its single components using the sap flow and lysimeter method for estimation of overstory and understory transpiration, and rainfall measurements above and below the canopy for estimation of interception. Based on these measurements in combination with modelling, the impact of afforestation on the hydrologic cycle and its components is analysed. Moreover, environmental factors controlling understory and overstory evaporation were identified. Our study demonstrates that afforestation alters green and blue water flows. It is concluded that a more water-conserving forest management for balancing soil erosion control and water resource demand needs to be established. Aim of this management should be to increase infiltration and deep percolation rate while minimizing water consumption of vegetation.

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ID 963

QUANTIFYING ECOSYSTEM SERVICE TRADEOFFS RESULTING FROM DRYLAND PLANTATION FORESTS FOR WATER AND FOOD SECURITY

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Forest is an important earth's ecosystem. FAO reported that planted forest area has significantly increased since 1990. The increment of planted forest areas is expected to continue and the diverse ecosystem services provided by these forests are of great value for sustaining global environmental and socioeconomic development. Expansion of planted forest over the past decades has taken place in some parts of the drylands. While planted forests consume greater water and leave less water available in drylands, conversion of cropland to forestland can lead to food shortage, resulting in tradeoffs between different ecosystem services. Dryland population largely depend on limited natural resources and their livelihoods are unstable and vulnerable to threats, such as water and food shortage, as well as land use and climate change. It is thus vital to understand the potential tradeoffs and involved opportunity costs, as they provide essential evidence to guide the decision making of afforestation efforts in drylands. For this purpose, we chose afforested dryland areas of Argentine, Chile and China between 2000 and 2015 for tradeoff analyses. We use remote sensing, downscaled Budyko framework, and regional specific crop coefficients to quantify the water consumptions (evapotranspiration) of grassland, typical rainfed cropland, and ecological plantation forest, which represent a low, medium and high potential risk of water security. In addition, the crop yield gap caused by converting rainfed cropland to planted forests is estimated for the tradeoff of food security. To calculate the opportunity cost, standardized price indicators are applied across regions. Our results implied that expanding forests by converting other land uses to plantation forests can introduce conflicts related to water and food security in water-scarce regions. More evidence are required to clarify the role of afforestation and their potential impacts on ecosystem service tradeoffs for dryland sustainable development.

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ID 968

WHAT DO WE KNOW ABOUT THE EFFECTS OF FORESTATION ON SOIL- AND WATER-RELATED ECOSYSTEM SERVICES IN THE ANDES?

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Several Andean countries have planned to restore forest cover in degraded and deforested land to enhance the provision of ecosystem services to society. In the Andean region, reduced water availability has been attributed to past forestation with exotic species thus fueling debate. Whereas the impact of forestation on water supply and regulation has been largely studied worldwide, critical information is missing in the context of Andean ecosystems where water scarcity is common along with steep terrain that favors soil erosion and landslides. To inform sound decision-making on forestation, we reviewed scientific evidence on the impact of forestation on water supply, water flow regulation, and soil erosion in the Andes. Following systematic review protocols, we searched peer-reviewed articles and unpublished thesis and reports. We synthesized studies using different methods, including meta-analyses and meta-regression. Forestation had clear positive impacts in degraded soils, through reducing soil erosion, increasing water infiltration, and improving low flows. However, total water supply was reduced by increased evapotranspiration of tree cover. At high elevations, restoration of Andean grasslands led to better hydrological outcomes than forestation. This is due to the good hydrological properties of grasslands and the detrimental effects of replacing them by exotic tree plantations. Forestation significantly reduced soil organic matter (an indicator of hydrological services and erosion regulation). However, land-use history before forestation had more effect on soil organic matter than, for example, management type, species planted, or age since planting. Important knowledge gaps include the impact of forestation on landslides susceptibility, water use efficiency, and potential differences in the impact of forestation between native and exotic species.

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ID 969

EVALUATING ECOHYDROLOGICAL FUNCTION OF TREE SPECIES IN ECOLOGICAL RESTORATION PROJECTS THROUGH THEIR FUNCTIONAL TRAITS

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Vegetation affects water balance partitioning via effects on incoming precipitation, local radiation balance and hydrological dynamics of soil. The extent of these effects is determined by physiological, morphological and anatomical characteristics of plants (functional traits). Therefore, the collection of plant functional traits in a hydrological system, determines its hydrological dynamics, and therefore, ecosystem benefits derived from this functioning. As a response to ongoing forest degradation, ecological restoration projects are intended to regain forest cover, ecological functionality and provision of ecosystems services. However, restoration projects are rarely assessed in their functionality and even very infrequently hydrological functions. Here we provide a novel monitoring framework to assess ecohydrological functionality of ecological restoration projects in strategic areas for water resources conservation. More specifically, we explore the connections between plant functional traits and ecohydrological processes that determine partitioning of precipitation in the canopy via stemflow and throughfall. We selected 10 species in an 8-year old ecosystem restoration project intended to protect hydrological functioning in a watershed that supplies a rural aqueduct in Medellín, Colombia. Our results show that, among all the evaluated traits, architectural and morphological traits describing tree crowns are significantly related with stemflow and throughfall, processes that transfer water to the soil. In addition, our results highlight differences in species traits that generate a gradient of differential effects on ecohydrological processes: from the wide and less dense crowns in Alnus acuminata to the smaller but more dense crowns in Quercus humboldtii, that significantly influenced the temporal variability of stemflow and throughfall respectively. More generally, our results highlight the need to include information about the effects of species planted in ecological restoration projects over ecohydrological processes, via robust criteria such as plant functional traits. This new framework allows a more objective planification of restoration projects based on ecosystem function and ecosystem service optimization.

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ID 970

BUENAS PRÁCTICAS DE MANEJO EN LA GESTIÓN FORESTAL DE PLANTACIONES FORESTALES EN CHILE: UNA EVALUACIÓN PARA CUENCAS PROVEEDORAS DE AGUA EN LA REGIÓN DE BIOBÍO.

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La adopción de buenas prácticas de manejo (BMPs) es considerada como uno de los indicadores de gestión más relevantes por parte de los propietarios de tierras, ya que en ellos se identifican las mejores tecnologías para el control de las externalidades ambientales según consideraciones de tipo técnico, social y económica. Como parte de un programa de investigación asociado a la gestión de cuencas forestales vinculadas al abastecimiento humano, el año 2015 el Instituto Forestal de Chile inició un programa de monitoreo para evaluar el la adopción de estas BMPs en la gestión de plantaciones de abastecen la industria forestal. Sobre la base de una serie de indicadores (procedimientos de gestión, análisis cartográfico de gabinete y revisión en campo post actividades de manejo) evaluamos el comportamiento de los grandes propietarios respecto al cumplimiento de acciones de manejo recomendadas para la protección del recurso hídrico en tres pequeñas cuencas abastecedoras de agua en la región del Biobío. En este trabajo se presenta la aproximación metodológica utilizada y los principales resultados respecto el grado de adopción de BMPs. Sobre la base de esta experiencia se identifican las principales brechas y se entregan recomendaciones para instrumentos de política voluntario o de comando y control, entre estos, estándares de certificación forestal, planes y normas de manejo forestal para plantaciones.

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ID 973

ADAPTATION OF ECOSER MAPPING PLATFORM TO TROPICAL MOUNTAIN BASINS IN THE COLOMBIAN ANDES: AN ASSESSMENT OF FOREST EFFECTS ON WATER-RELATED ECOSYSTEM SERVICES

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The growing demand for natural resources and population growth has led to changes in ecosystems from land use and land cover change. These dynamics can alter ecosystem function, compromising their capacity to provide goods and services to the population. To assess the impacts of these changes, several tools have been developed worldwide. However, it is necessary to adapt and refine

modeling tools that allow the mapping of ecosystem functions and services to local contexts, considering the particularities of the territory. One of these mapping tools is the ECOSER Collaborative Protocol, which has been developed for ecosystems in southern South America. We evaluate and adapt this protocol, which has been used in multiple ecosystems of South America, to the particularities of a strategic basin for the provision of water and the generation of energy in the central Andes of Colombia. Our work focuses on the ecosystem functions of Water Regulation and erosion control. The proposed adaptation includes the implementation of a physically-based hydrological model (for the function of hydrological regulation) and different alternatives for the estimation of soil erosion. Subsequently, an expert consultation is developed to determine the transition from function to ecosystem service, to finally perform SE mapping. Carrying out this adaptation and subsequent implementation of the ECOSER Collaborative Protocol to the local context allows a clearer understanding of the interactions between its behavior and the services derived from it. This adaptation also allows assessing tools for the management and planning of the territory, particularly in regions where multiple ecosystem services and land-use pressures threaten the integrity of natural ecosystems and their capacity to provide essential services to society.

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ID 974

CAMBIO DE USO DEL SUELO Y POLÍTICAS DE GESTIÓN PARA LA PROVISIÓN DE SERVICIOS ECOSISTÉMICOS RELACIONADOS CON EL RECURSO HÍDRICO. UN MODELO DE DINÁMICA DE SISTEMAS.

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Los sistemas socio-ecológicos (SES) funcionan por la coacción entre especies (fauna y flora), interacciones sociales y las relaciones entre los ecosistemas y bienes antropogénicos. Las políticas de manejo, están diseñadas como respuestas a los cambios y efectos que los factores endógenos y exógenos ocasionan en los sistemas ecológicos. Es importante considerar no sólo las funciones dentro del sistema natural sino las interacciones dentro y entre los componentes de los SES, para evitar resultados perjudiciales y adelantarse a la respuesta del sistema frente a políticas de manejo y acciones de presión. Esta investigación tiene como objetivo, determinar los impactos causado por el factor endógeno de cambio de uso del suelo y diferentes políticas de manejo relacionadas con el recurso hídrico en una microcuenca hidrográfica sobre el sistema socio-ecológico asociado. Los SES son complejos y se caracterizan por tener ciclos de realimentación y por su no linealidad, por lo tanto, una herramienta útil para comprenderlos es por medio de modelos de Dinámica de Sistemas (DS). Esta investigación usa un modelo de DS para modelar los efectos de una política de manejo y el cambio de uso del suelo

en todo un sistema socio-ecológico en una microcuenca, ubicada en el corregimiento de Santa Elena, municipio de Medellín, Colombia, abastecedora de agua y con intervención forestal de árboles nativos. Los resultados de la investigación evidencian el impacto que generó la reforestación realizada en la microcuenca y el cambio de uso del suelo en el recurso hídrico sobre el sistema socio ecológico de la microcuenca San Pedro, y muestra casos hipotéticos con respecto a la aplicación de una política más rígida. Esta investigación resalta la importancia que tiene los SES en las políticas de manejo para reducir las presiones sobre el sistema natural y finalmente mantener el flujo de servicios ecosistémicos para garantizar el bienestar social

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ID 980
EFFECTS OF WILDLAND FIRES ON STREAMFLOW IN THE CONTIGUOUS UNITED STATES

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Wildfires threaten municipal water supplies by altering water quantity and quality, ecosystem structure, soil properties, flow pathways, evapotranspiration rates, and particulate matter emission and deposition. However, the effects of wildland fires on U.S. water supplies have not previously been measured, nor factored into regional water management strategies. We selected 168 gauged watersheds in the continuous United States (CONUS) based on long-term (1984-2013) records of burned area and severity, streamflow, and climate data. We combined change point models, double mass analysis, Gradient Boosting Machines, and climate elasticity modeling to detect streamflow change and determine relative contribution of wildland fire and climate to observed change in river flow. Next, we applied a monthly water balance model (WaSSI) to 88,000 HUC-12 watersheds in the CONUS and scaled the simulations to the 18 Water Resource Regions (WRRs) to examine the sensitivity of the hydrologic response to changes in vegetation structure (i.e., leaf area index) and soil porosity. Our study suggests that the responses of streamflow of large watersheds to wildfires vary across different regions due to differences in climatic and management regimes, and area burned. For example, in the arid western U.S., mean river flow increased up to 6 times in the 5 years following large wildland fires, while flow change attributed to wildland fire in the humid eastern U.S. was not significant. Annual river flow changed in 32 locations where more than 19% of the basin area was burned. We conclude that wildland fires enhanced annual river flow in the western regions with a warm temperate or humid continental climate. In contrast, prescribed burns in the subtropical southeastern region did not significantly alter river flow at the scale examined.

Outcomes suggest that effective management strategies to minimize hydrological impacts of wildland fire must adapt to the local climatic and fire regimes.

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ID 981
CLOSING THE FOREST HYDROLOGY LOOP: A CASE STUDY OF SURFACE WATER AND GROUNDWATER INTERACTION WITHIN A SOUTH AFRICAN PINE PLANTATION

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In water scarce South Africa, natural forests are limited in extent and the country is reliant on plantations of introduced tree species for its fibre and timber requirements. These highly productive tree systems replaced lower leaf area vegetation such as grassland and scrub, causing increases in evapotranspiration with resultant changes in hydrological dynamics of afforested catchments. Paired catchment experiments and later process measurements, combined with modelling, quantified stream flow reductions associated with tree plantations. Regulation of the industry ensued to ensure equitable water allocation. However, while quantifying stream flow reductions suffices for regulation, it represents a "black box" approach to groundwater and surface water interaction. Groundwater, an increasingly important resource for water supply in South Africa, is impacted by plantations through direct abstraction, if conditions permit, and reduced recharge. In this study, the hydrological processes in a catchment characterised by a mosaic of two Pine species plantations and indigenous afrotemperate forests, and generally a fractured rock aquifer environment were monitored over four years. The catchment is located in the southern Cape region of South Africa. A novel combination of sap flow, eddy covariance, groundwater, weather, and soil water monitoring, was combined with modelling. The mean annual precipitation over the monitoring period was 835 mm, including a dry 2016/17 total of 639.6 mm. Annual transpiration totals for the Pinus radiata and Pinus elliotii stands were 640 mm and 575 mm respectively in 2016/17, while mean evapotranspiration totals for the two stands over the entire monitoring period were 712 mm and 868 mm respectively. Modelling indicated significantly higher potential groundwater recharge in the indigenous forest compared to the Pine plantation stands. Coupling micro-meteorological

evapotranspiration measurements with groundwater monitoring and recharge modelling provided insight into the linkages between these hydrological processes.

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ID 989

SOCIAL PERCEPTIONS ON THE FOREST ROLE ON WATER CYCLE: IMPLICATIONS FOR FOREST GOVERNANCE AND WATER-BASED ECOSYSTEM SERVICES IN TROPICAL COUNTRIES

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The role of forest on water cycle has based public policies and initiatives in several countries. But to efficiently manage forest in order to provide water operative norms are not sufficient and they must also be supported by and complied with social stakeholders. Here, we analyze social context and perceptions of different stakeholders in tropical countries on forest importance in order to supply water-based ES (i.e. water regulation and water provision). We used a two-methodological approach, in-depth interviews and a massive online survey, to assess perceptions of key persons on decision making, forest practitioners, academics and the civil society in countries from Africa, Australia, Neotropic and the South Pacific. We identified differences emerging in the awareness people have on the forests role on water-based ES supply, and how these awareness are embraced in public policies, in programs and initiatives leaded by public agencies (i.e. public discourse and policies and governmental actions), but also manifested in actions leaded by civil society. In Australia, public commitments protect and restore forests due their importance to water supply, while in Africa water is becoming a key component and governments have been decided to actually merge issues of forest and water in terms of environmental management. In South Pacific any action of people to preserve or manage the forest depends very much on the location (i.e., island type), while the Neotropics appear to be much variable in terms of countries. Land tenure is other main difference influencing forest management. We concluded that the perception and inclusion of ES approaches is heterogeneous among the four regions, and is associated with some 'social' aspects of governance such as capacities, transparency, and cooperation, mainly due with disparity in the legal frameworks and institutions that regulate forest management, but also with different approaches to manage the access and distribution of these services.

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ID 990

OPPORTUNITIES FOR IMPROVING WATER SUSTAINABILITY OF INTENSIVELY MANAGED EUCALYTPUS PLANTATIONS

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Water use of Eucalyptus plantations has been considered a conflict and challenge for social, ecosystem and productive water needs across many regions around the world. We evaluated water use, water use efficiency and the efficient use of water of sixteen Eucalyptus globulus, E. nitens and hybrids under irriigated and non-irrigated conditions at large scale experiments established at two contrasting climate sites (high VPD vs low VPS) using continuous monitoring of individual tree and stand transpiration using Granier sensors, growth, biomass ecophysiological assessments and climatic data. Our results suggest that early selection of spefic genetic materials based on their ecophysiological assessment and modelling of their water use, may provide a tremendous opportunity for allocating specific genotypes to areas where major conflict for water resources may exist or arise. This strategy may provide a scientific rational approach to improve standards of water sustainability of intensively managed forest plantations fullfilling social, environmental and productive needs.

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ID 991

SIMULATING EFFECTS OF LANDSCAPE COMPOSITION ON WATER AVAILABILITY TO DOWNSTREAM WATER USERS

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Forest plantation areas have been expanding in Brazil with increasing concerns about water consumption by these forests, especially in water-limited regions with consequences for downstream users. The decrease in streamflow following forest plantation is related to high productivity characteristics and, consequently, with high evapotranspiration rates, the main challenge for planning and management forest plantations is reconciled the plantations water consumption to the others

water uses. In this context, our objectives were to simulate two scenarios of forest plantation landscape composition (i) forest cover proportion (100%, 50% and 0% of catchment area) using the model forest cover flow change (FCFC), and (ii) forest age mosaic using a mathematical model adjusted for the study catchment. Moreover, we used low flow indices (Q90 and Q7,10) to examine the effect of such scenarios on water availability to downstream users. Our study area is a gauged catchment (85 ha) located in São Paulo State, Brazil, covered with fast-growing Eucalyptus sp. plantation. Our results showed an increase of 90% on annual streamflow from 0% forest cover scenario in relation to 100% forest cover scenario. For the same forest cover proportion, forest age mosaic scenarios showed a lower decrease in streamflow when compared with even-aged forest plantation scenarios. The scenario of 100% forest cover presented streamflow below the low flow indices, resulting in less water availability to downstream water users. Scenarios from different forest ages mosaic (two patches) promoted an attenuation of water use since low flows in these scenarios were higher than scenarios without mosaic. Therefore, forest plantation management could adopt strategies such as the proportion of clear-cut and mosaic of forest age to minimize effects on the water supply to downstream water users.

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ID 992

AQUATIC LITTER DECOMPOSITION IN RIPARIAN VEGETATION UNDER THE INFLUENCE OF EUCALYPTUS TREES

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The presence of exotic species in riparian environments can influence the quality of leaves that are relocated in the ecological system. The objective of this study was to determine the influence of Eucalyptus saligna on aquatic decomposition in three watersheds, located in semideciduous seasonal forest in the state of São Paulo, Brazil. The litterfall used in measure the decomposition were collected using 12 collectors of 0.25 m2 that were systematically allocated on streams studied. To evaluate aquatic litter decomposition rate, leaves from Eucalyptus (E), native species (N) and a mixture of Eucalyptus/native trees (E/N) in a ratio 1:1 were introduced in litter bags. The samples of aquatic decomposition were collected 7, 14, 28, and 56 days after experiments installation. The statistical analysis evaluated the rate of loss of organic matter over time. We considered the rate of loss of organic matter or decomposition (k) according to the type of leaf and watershed. Multiple mean comparisons (Tukey-Kramer) test at 5% were used for treatments and significant interactions. We found significant effects of watershed in leaf type and the interaction between watershed and leaf type . Only one watershed showed no

significant differences in the decomposition between the studied leaf types . In general, we observed that native leaves had the highest losses of organic material over time compared to Eucalyptus leaves. The mean half-life rate for each leaf types E, N and E/N to all watershed were 187.67, 146.41 e 95.39 days. The presence of Eucalyptus saligna in the riparian zone can alter the decomposition process; therefore it is fundamental to consider this occurrence in the planning and location of Eucalyptus trees within these areas to maintain the ecological integrity.

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ID 997

FREQUENT-FIRE CONIFER FORESTS OF NORTH AMERICA: UNDERSTANDING TRADE-OFFS BETWEEN WATER YIELD AND CARBON SEQUESTRATION

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Many conifer-dominated forests in North America are characterized by, and adapted to, short fire return intervals (<35 years). These frequent-fire conifer ecosystems, or FFCE's, are characterized by low basal area, a sparse mid-story, and a diverse herbaceous layer maintained by low-intensity surface fires. We hypothesized that this characteristic structure supports a unique suite of ecosystems services, including the potential to support relatively higher water yield than nearby forest types; however, high water yield might come at the cost of reduced carbon sequestration. We reviewed literature addressing water and carbon fluxes in a range of FFCEs in North America with the goal of identifying characteristic positive and/or negative impacts of frequent fire and fire suppression on forest water and carbon budgets. The systems we identified were primarily dominated by Pinus species including P. palustris, P. elliottii, P. ponderosa, P. echinata. We found that these FFCEs generally had lower stand-level transpiration rates than nearby forests under similar climate and soil conditions; but, relatively low tree density and frequent surface fires also decreased carbon sequestration rates in the short-term. However, these characteristics also reduce the risk of catastrophic crown fires that can release large pulses of carbon and simultaneously reduce water quality through severe soil erosion. While differences in water and carbon cycling between frequent-fire and fire-suppressed sites were apparent, the magnitude of the differences among fire regimes varied greatly depending on species composition and abiotic factors such as climate, topography, and site history. Effective use of prescribed fire and managed wildfire is a critical tool for managing these FFCEs for wildlife and other

conservation objectives. This same management philosophy also appears to increase the provision of other ecosystem services in these forests, including water, which adds considerable value to programs promoting restoration of fire in these ecosystems.

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ID 1001

UN MODELO DE ANÁLISIS ESPACIAL MULTI-CRITERIO PARA EL RESGUARDO AMBIENTAL Y SOCIAL EN LA POTENCIAL EXPANSIÓN FORESTAL IN CHILE

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Al nivel global las plantaciones forestales de rápido crecimiento han expandido de forma exorbitante, llegando a proporcionar sobre 30% de la madera en bruto de la industria forestal. WWF advierte que por el crecimiento de la población mundial, la demanda de productos forestales probablemente conlleva al establecimiento de 250M de ha de nuevas plantaciones. El desarrollo de las plantaciones actuales ha sido eje de considerable controversia y hay una historia de malas prácticas innegables, así como dudas en cuanto a su impacto en la disponibilidad hídrica. Es necesario contar con herramientas para facilitar una planificación territorial para evitar impactos negativos de la expansión de plantaciones. Desde la visión de WWF, una condición para las plantaciones es que no debe vulnerar ni la integridad de los ecosistemas ni los medios de vida o derechos de las personas. Para esto, WWF seleccionó la cuenca del río Valdivia, ubicada en el centro sur de Chile, un paisaje con aproximadamente 209.000 ha de plantaciones forestales; y elaboró una propuesta de modelo basado en la metodología de análisis multicriterio, utilizando Sistemas de Información Geográfica, y conjunto con la participación de actores claves para la valoración de promedios ponderados de variables que se alinean con el concepto de New Generation Plantations que exige mantener la integridad ecológica y tener participación efectiva para una producción responsable. El ejercicio generó una espacialización de la sensibilidad ambiental y social a la potencial expansión de las plantaciones forestales dentro del área de estudio. Se propone el modelo como una herramienta de planificación espacial de los paisajes con base en la ciencia y amplia participación, aplicable por tomadores de decisión para disminuir los riesgos de una expansión no adecuada de las plantaciones forestales. Los resultados del modelo permiten abrir la conversación sobre el futuro uso forestal de los paisajes.

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ID 1005

LARGE-SCALE FOREST DISTURBANCE AND SUBSEQUENT RECOVERY INFLUENCE THE TRADEOFF BETWEEN FOREST CARBON AND WATER SERVICES IN BRITISH COLUMBIA, CANADA

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British Columbia's public forests are primarily managed for timber production and the provision of various ecological functions and services. Over the last 20 years, a large-scale Mountain Pine Beetle (MPB) epidemic has killed 20 million hectares of mature Lodgepole pine in the Province's interior region. This has been accompanied by accelerated levels of salvage logging and large wildfires in some watersheds. The high levels of forest disturbance, along with subsequent recovery can alter ecological processes. The objective of this study is to quantify how this recent large-scale forest disturbance and recovery have affected the possible trade-off relationship between forest carbon and water resources. This study uses data from 50 primarily forested watersheds with long-term streamflow records (>= 30 years), ranging in size up to 55,000 hectares. Forest change caused by disturbance and recovery are quantified using watershed-level equivalent disturbance area (EDA), and forest carbon sequestration and stocks are simulated using the Carbon Budget Model of the Canadian Forest Service (CBM-CFS3). Various statistical techniques are employed to quantify how EDA has impacted forest carbon and streamflow, and how the trade-off relationship is altered. Our preliminary results indicate that forest disturbance significantly reduced forest carbon sequestration and stocks. However, rapid growth of understory vegetation and regeneration can offset this reduction. Forest disturbance and recovery affect annual streamflow in opposite directions. Additionally, water use efficiency at the watershed-level showed dynamic patterns over spatial and temporal scales. These results have important management implications for British Columbia where there is a mandate to manage public land for many social and ecological services.

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ID 1011

INFLUENCIA DE LOS CAMBIOS DE LAS COBERTURAS FORESTALES EN LA VARIACIÓN DE CAUDALES EN UNA CUENCA DE LOS ANDES VENEZOLANOS

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Los Andes Venezolanos constituyen una zona de vital importancia para la producción de recursos hídricos en el país, los cuales son utilizados para

abastecimiento de agua potable, riego de cultivos, procesos industriales y generación de energía eléctrica. La Cuenca del Río Uribante, ubicada en el estado Táchira, posee uno de los complejos hidroeléctricos más importantes de la zona, en los últimos años el suministro eléctrico de la región se ha visto seriamente afectado sin haberse hecho estudios detallados de los elementos que constituyen el ciclo hidrológico, su dinámica y sus efectos en el aporte de agua al embalse. Es por ello que se realizó un estudio multitemporal para el período 1990-2017 de la cobertura vegetal, mediante la clasificación de imágenes LANDSAT utilizando el método Random Forest, en el software estadístico R, por otra parte se realizó un análisis hidrológico con el software WEAP para evaluar cómo influye la dinámica que ha tenido la cobertura vegetal en la cantidad de agua que produce la cuenca. Los resultados preliminares muestran que, contrario a lo esperado, hay una ligera recuperación de la cobertura de bosques, pero a la vez hay un rápido dinamismo en la cobertura vegetal de la cuenca con influencia en los patrones de producción de agua. Las complejas interacciones que determinan la dinámica de la cobertura forestal y su influencia en disponibilidad de agua en la cuenca hace necesario la evaluación detallada de los factores que determinan estos cambios, para poder tomar acciones más precisas en la conservación y sostenibilidad del recurso.

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ID 1014

NATIVE AND EXOTIC FOREST SPECIES: SIMILAR OR DIFFERENT IN WATER USE EFFICIENCY?

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This research aims to characterize, quantify and compare the relationships flows (transpiration, stomatal conductance and photosynthesis) between Eucalyptus sp and native forest species in Brazil of different successional groups (pioneer and non-pioneer) under the same water conditions, nutritional and climate. The objective is to provide scientific and technological basis of the efficiency of water use by these species. Amid the many questions and doubts about the water consumption of exotic species, the first question arises: After all, is there any similarity in the efficiency of water use among native species and Eucalyptus sp? By studying the soil-plant-atmosphere relations of this exotic species, was found in the lack of information concerning the ecophysiological behavior of native forest species in Brazil, as well as ecophysiology "intrinsic" between pioneer species, pioneering and exotic. Even though Brazil is the territory with one of the greatest diversity of tree species in the

world, there is not yet quantified gap in the scientific literature in this regard. In addition to the proposed objective, the research will support discussions and methodologies involving the contribution or implication of commercial x native forests in the water balance of watersheds, climate change beyond lines aimed at forest restoration, scaling up and specifics on the water requirement of species.

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ID 1017

DECLINE IN CATCHMENT RUNOFF WITH INCREASING FOREST AGE AS A FUNCTION OF LATITUDINAL CLIMATE DIFFERENCES IN CHILE AND IMPLICATIONS FOR AN ANALOGUE OF CLIMATE CHANGE IMPACT

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Several decades of research on experimental forest catchments have laid the basis for general conceptual models relating reductions in annual water yield to increases in the proportion of a catchment covered by forest and to the growth, or age, of new plantations. In some cases there have been attempts to modify the model as a function of tree type but there are few examples of modifications as a function of climatic condition. However, the latitudinal variations in climate through the main forest plantation zone of Chile provide an excellent context for such study. Data from two groups of experimental catchments with contrasting climatic conditions in central-southern Chile are therefore used to examine the trend of annual runoff coefficient decline with increasing plantation age for Pinus radiata and Eucalyptus spp., which make up most of the 2.7 million ha of planted forests in the country. The sites lie about 300 km apart at approximate latitudes 37° and 40° south, with respective annual rainfalls of about 1000 and 2000 mm. The eucalyptus data show strong differences: runoff coefficients are lower for comparable tree ages (e.g. 0.125 vs 0.55 at 10 years) and decline faster in the northern and dryer sites than in the southern and wetter sites. The pine data are less extensive but appear to show less distinction between the northern and southern sites and a transition to low runoff coefficients only as the trees approach maturity. The rate of runoff increase following logging is also greater in the north than in the south. These results are proposed as an approximate analogue of the changes in forest hydrology which may occur at a site as vegetation belts shift latitudinally under the impact of global warming.

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ID 1018

ASSESSMENT OF THE EFFECT OF DIFFERENT THINNING INTENSITY ON THE WATER CYCLE OF THE CONIFER PLANTATION IN SOUTH KOREA

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In order to clarify the effective forest management method for the enhancement of water resources in preparation for climate change and water shortage, we examined the effect of different thinning intensities on the water cycle in a conifer plantation. The study site is located in the northern part of South Korea, with an average annual precipitation of 1,502.9 mm and an average annual temperature of 11.2 degree Celsius. The forest of the study site is a 40-year-old Korean pine (Pinus koraiensis) plantation with an average height of 14 m, an average DBH of 20 cm and a total growing stock of 756 square meters, reaching 243 square meters per ha. To apply different thinning intensities, the study site with a total area of 3.1 ha was divided into three well separated small catchments. In order to understand the base conditions of the water cycle characteristics before thinning, we have been monitoring the runoff, soil moisture, canopy interception and meteorological factors under canopy in each catchment since 2011. Thinning was carried out from December 2016 to February 2017. In two of three small catchments, 30% and 50% of trees were thinned based on the number of live trees, respectively. The remaining one small catchment was not thinned as a control. Thinning works were carried out uniformly over the whole area of each catchment, and the harvested trees were taken out by a wire harvesting method to minimize soil disturbance. As the results of observing changes in water cycle for each small catchment for one year after thinning, the canopy interception decreased in proportion to the thinning intensity, and the soil moisture increased in proportion to the thinning intensity. The runoff was increased in the both thinned catchments, but the increase was more pronounced in the 30% thinned catchment. But, peak flow rates and sediment runoff were founded to increase significantly in the 50% thinned catchment. Forest thinning has immediate effects on the increase in water supply. However, since the risk of flood and sediment disaster may increase when high intensity thinning is carried out, thinning intensity should be carefully selected depending on climate and environmental conditions.

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ID 1020

WATER USE DURING AND AFTER SEVERE DROUGHT IN A PINE-DOMINATED FOREST: COMPARING FUNCTIONAL GROUP DIFFERENCES IN EVAPOTRANSPIRATION

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Climate models for the southeastern United States predict increased drought severity and frequency, with potential negative impacts on forest health and water yield. This region was once dominated by longleaf pine [Pinus palustris Mill. (Pinacea)]; and restoration of this foundation species has been proposed as a means to mitigate drought impacts. To better understand the effects of drought on longleaf pine forests, we measured sap-flux (Js) of six tree species (Pinus palustris and five Quercus spp.) during the 2016 and 2017 growing seasons. The latter part of the 2016 growing season was characterized by a severe drought during which our sites received <6 mm of rainfall over 72 days (versus a normal mean of ~260 mm). Conversely, 15% more rain fell during the 2017 growing season, with no prolonged dry periods. To understand responses of longleaf pine and oaks to drought, we compared short-term effects of the drought on Js and total sap-flux between growing seasons. We observed strong differences between functional groups in both total water use and in Js responses to drought, although these differences varied considerably depending on timing relative to the drought. During the drought, pines tended to downregulate Js, especially in smaller trees (<20 cm dbh). Average Js of these trees during the drought was 76-80% lower than the pre-drought average. In 2017, Js of Quercus species increased 33% relative to 2016, but Js in longleaf pines decreased 15%. Short-term drought response in these species reflects typical isohydric (Pinus) and anisohydric (Quercus) behavior observed for these tree genera in other systems, and may help inform watershed restoration priorities. However, the lowered sap-flux rates in longleaf pine following the drought also suggest that severe drought may affect pine Js for a much longer time period relative to oaks, and raises concerns about future forest health.

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ID 1022

LONGLEAF PINE RESTORATION FOR STREAMFLOW IN THE LOWER FLINT RIVER

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Water scarcity in the southeastern United States has increased in recent decades due to rapid population growth, land use intensification, and climate variability. While precipitation in the region is relatively high (~1300 mm/year), declines in river discharge suggest a growing need to evaluate land management options focused on reducing evapotranspiration and maintaining watershed yield. Restoration of

longleaf pine [Pinus palustris Mill. (Pineaceae)] forests, which once dominated the southeastern United States Coastal Plain, represents one possible land management option to restore hydrologic function and help mitigate water scarcity in the region. Ichawaynochaway Creek is a major tributary of the lower Flint Basin, which largely overlaps with the historic range of longleaf pine and has seen recent conflicts over water appropriations. We used the Soil and Water Assessment Tool to evaluate the potential effect of large-scale longleaf pine restoration to affect streamflow in the Ichawaynochaway Creek Basin. Specifically, we simulated the conversion of ~24,000 ha of degraded mixed-species forest to longleaf pine savanna. Model results confirmed that longleaf pine savanna has the lowest demand for water as evapotranspiration compared to other major vegetated land cover types in the Ichawaynochaway Creek Basin. Conversion to longleaf pine increased monthly streamflow <5%, with relatively larger impacts during low and extremely low flow periods. Results indicated that longleaf pine restoration is an effective way to increase streamflow, with the majority of reduction in evapotranspiration being converted into the streamflow. Although the change in annual yield was relatively small, it may prove vitally important in maintaining quality in-stream habitat for imperiled aquatic organisms during seasonal droughts and critically dry periods. Large-scale restoration of longleaf pine savanna could help mitigate water scarcity in the Ichawaynochaway Creek Basin by reducing watershed evapotranspiration, especially during drought.

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ID 1026

SIGNIFICANT CHANGES IN WATER QUALITY CAUSED BY PEATLAND DEFORESTATION AND EXTREME STORM EVENTS IN SCOTLAND

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In this paper we present two forest hydrology research studies, one describing the effects of climate change adaptation measures (peatland deforestation) on drainage water quality and another reporting climate impacts (extreme storms) on stream water chemistry. Peatland deforestation is occurring in the tropical and temperate zones with implications for ecology, water quality and global warming. In Scotland climate change concerns and the Scottish Government's Climate Change Plan are driving large-scale deforestation of non-native coniferous trees from a number of peatland sites; the aims include habitat restoration and protection of soil carbon stocks but concerns have been raised about the impact of such a rapid change in forest cover on water quality, particularly in terms of dissolved organic carbon transport but also nutrient losses. Eutrophication has been reported in local waters supporting sensitive species such as the freshwater pearl mussel following deforestation on peat; the mussel is threatened throughout its Holarctic range and slipping to extinction, placing even greater importance on the need to

protect remaining viable populations. In this presentation we present the results from over nine years of pre and post-deforestation water quality monitoring at a peatland site in central Scotland which was extensively planted with non-native conifer trees in the 1960s and 1970s and is being progressively cleared to restore peatland habitat. We also present data from a long-term study (23 years) where we are investigating the effects of afforestation and forest growth on water quality. A cyclone hit the site in December 2011 and was followed by another violent storm in 2012. The impact of the storms on water quality was remarkable causing changes in water quality not seen in the previous 17 years of monitoring.

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ID 1030

THINNING CAN MEDIATE THE NEGATIVELY HYDROLOGICAL EFFECTS OF DROUGHT: INSIGHT FROM A YOUNG LODGEPOLE PINE FOREST, BRITISH COLUMBIA, CANADA

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Naturally regenerated young lodgepole pine (Pinus contorta) forests following stand-replacing disturbances are commonly observed as over-dense and uniform cohorts, and such extremely high densities may produce undesired economic and ecological functions over a significant period. Juvenile thinning that reduces stand density was suggested to be a possible sustainable practice for improving tree growth and enhancing trees' ability to cope with climate change impact. However, those potential benefits of thinning are rarely tested in lodgepole pine forests. The objective of this study was to investigate the effect of juvenile thinning on forest carbon sequestration, water use and water-use efficiency (WUE, the ratio of basal area increment (BAI) to tree transpiration (E) at the individual tree level) and to further examine if thinning can mediate the negative effects of drought in a 16-year-old natural Pinus Contorta stand. The drought year (2017) provided an excellent opportunity for accomplishing the research objective. Three randomized blocks (20 m ×60 m each) with each having two thinning intensities plots (T1: 4,500 and T2: 1,100 stems per ha.) and one unthinned plot (C: 26,933 trees per ha.) were established in the Upper Penticton Watershed in semi-arid interior in British Columbia in Canada. Results showed thinning significantly enhanced daily BAI, E and soil volumetric water content (VWC) in both years. Due to the drought in the summer of 2017, T2 had 19% reduction of daily BAI, significantly lower than those in both T1 (45%) and C (45%), while it maintained significantly greater sap flow velocity and VWC as compared to T1 and C. As a result, WUE was only significantly different among T2, T1 and C in 2017,

with T2 having the highest WUE. These results clearly demonstrate that the more intensive thinning can mediate the drought effect in young lodgepole pine forests.

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ID 1037

WATER GOVERNANCE NETWORKS' INFLUENCE ON WATER ECOLOGICAL SYSTEMS OVER TIME: AN OKANAGAN VALLEY, CANADA CASE STUDY

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Over time, social-ecological systems may be enhanced through multi-level collaboration. Nelson's doctoral research presented here explores the linkages between water governance networks and ecological outcomes at the watershed level. His research focuses on the value of longitudinal (30-40 year) datasets on water governance networks and water quality, specifically valley bottom large-lake phosphorus levels. Ecological signals often take decades to manifest and are influenced by confounding variables including: changing population, increasing climate variability, and morphing multi-level governance networks. Water governance networks are an expression of formal and informal relationships, rules, and institutions; and may play a meaningful role in water ecological system outcomes. Focused on a case-study of the Okanagan watershed, Nelson's research explores the influences of governance networks and water quality changes over time. Social network analysis is one lens into the 'social' component of social-ecological systems. Nelson will present recent findings on longitudinal water governance network analysis and relationships to regional water quality experienced throughout the region. This research informs multi-level and polycentric governance networks, including indigenous government co-management, that require new solutions to solve contemporary water problems. Collaboration is one of the lenses that Nelson explores as an important variable in integrated water management. Developing a better understanding of water governance networks provides insights into how social-ecological systems may be improved with increasing human population and climate variability.

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ID 1039
THE FOREST-WATER DIVIDE – IS MORE DEBATE REALLY NECESSARY?

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Rapid population growth, increasing agricultural production, mushrooming urban (and suburban) settlements and the continuous decline of forest cover bode ill for the delicate balance between carbon, water, energy and climate. Climate change further exacerbates the already fundamental imbalances created by the anthropogenic modification of terrestrial landscapes, creating complex and interactive feedbacks across these two phenomena. Globally warming temperatures and declining rainfall (at least in the tropical and temperate regions), both compound and further aggravate an increasingly grim misuse of the available planetary resources. Most concerning of all, conventional forest management strategies based on the predominant view of forests and water interactions could result in additional reductions of the existing continental atmospheric moisture budget, further endangering the livelihoods and lives of those at greater risk. The policy realm's response to this twofold onslaught and challenge is either woefully inadequate or, at least in the forest-water case, entirely absent. Where the forest-water debate is concerned, however, the scientific world remains divided into easily politicized camps, seemingly unable to observe and adequately understand what the other camp is up to. The reasons for this, however, are unclear. Many or most of the tools necessary for repairing at least a part of that delicate balance between the major ecosystem components are increasingly well understood and documented. Moreover, an optimized ecosystem strategy could effectively use these tools to at least partially address the rapid advance of climate change and its increasingly threatening impacts on the availability of at-risk water resources, and on the million to billions of people and livelihoods that depend on them. Given this state of affairs, how are we to proceed? What is the key to resolving the decades, even centuries, old forest-water debate? Is the Science – Policy interface broken? And if so, how can we embark on trying to fix it?

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ID 1041
ENVIRONMENTAL CONTROLS ON NOCTURNAL SAP FLOW IN PINUS TABULIFORMIS AND ACER TRUNCATUM FOREST UNDER DIFFERENT STAND AGES IN NORTHERN CHINA

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Exploring the characteristics of forest nighttime water use and its environmental controls are helpful to understand and predict how forest ecosystem responds to the more frequent occurred drought under the global change. In the rocky

mountain of Beijing, the northern of China, which under the prolonged soil water stress, the nocturnal sap flow of two indigenous dominate afforestation species, Pinus tabuliformis and Acer truncatum, were measured in half-mature and saplings stands by thermal dissipation methods during the growing season in 2013, as well as the simultaneous variations in meteorology and soil water content. The environmental controls were obtained by the path analysis. We found the vapor pressure deficit, wind speed and soil water content jointly explained the 33~59% variations in nocturnal sap flow for P. tabuliformis and A. truncatum forest with different stand ages. The significant but opposite impacts of vapor pressure deficit on nocturnal sap flow seemed related with the nighttime canopy transpiration which influenced by the soil water condition. Besides the indirect influences of wind speed by affecting the vapor pressure deficit, wind speed also directly promoted the nocturnal sap flow of the half-mature P. tabuliformis stand, which might due to its higher cuticular water loss in this less dense stand. As for soil water content, it was the soil water stress that directly encouraged the nocturnal sap flow other than the wet soil as reported by other researches. With the climate of this region became more arid, tree species might chronically exist nighttime refilling of capacitance or/and desiccation-rehydration in stem tissue, and became more obvious when soil water content decreased. Our study highlight the drought influence on forest nighttime water use strategy. Further researches need to differentiate the nighttime refilling and transpiration to thorough clarify the mechanisms of soil water conditions on forest water use.

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ID 1043

LINKAGES BETWEEN LARGE-SCALE CIRCULATION PATTERNS AND LONG-TERM LEAF LITTER DYNAMICS OF SCOTS PINE AND EUROPEAN BEECH MIXTURES IN THE PYRENEES

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Litterfall represents the main connection between vegetation and soils in terms of matter, nutrients and energy in forest ecosystems. Leaf litter production and seasonality, and therefore nutrient return, are greatly modified by species composition, site conditions and water availability, which is ultimately determined by large-scale circulation patterns. In this study, we explored leaf litter production and seasonality of two Scots pine (Pinus sylvestris L.) and European beech (Fagus sylvatica L.) mixed stands with contrasting characteristics of the southwestern Pyrenees (Spain). Litterfall was collected monthly during autumn for a 16-year period. Relationships with local climate, which was assessed through the standardized precipitation evaporation index (SPEI), and large-scale climatic indices (NAO, ENSO and PDO) were analyzed. Temporal series of leaf litter and

climatic variables were decomposed following the ensemble empirical mode decomposition (EEMD) method. For both species leaf litter seasonality was better explained by Pacific Ocean's circulation patterns (i.e. ENSO and PDO). The influence of large-scale patterns was interpreted considering their impact on water availability. On one hand, summer droughts induced premature abscission of Scots pine needles since water stress prevent from maintaining foliage biomass and accelerates the fall of the older needles. On the other hand, heavy rain in autumn hastened shedding of European beech leaves due to the physical impact exerted by precipitation that can remove old and senescent leaves from the canopy. Leaf litter dynamics are key processes to better understanding functioning of mixed-species forests owing to their large impact on nutrient return and thus nutrient limitation, which has direct and indirect effects on forest adaptation to global change. Our results suggest further changes in leaf litter dynamics in Scots pine – European beech mixtures as climate has been predicted to become drier with more frequent extreme precipitation events in the study region.

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ID 1045

ET PARTITIONING IN A SEMIARID COPPICE FOREST FOLLOWING SCRUB CLEARING AND THINNING

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In water-oriented silviculture, the effects of cultural treatments on ET components (interception, It; soil evaporation, Es; and transpiration, T) may vary according to site conditions, climate and forest structure (both physical and biological). Under semiarid conditions, gains in net precipitation (decrease in It) following thinning treatments may be offset by increased Es and T. In this work, we address the temporal pattern of these three components (It, Es ad T) as affected by scrub clearing and thinning in a marginal holm oak forest growing in Eastern Spain under Mediterranean climate. Using both, empirical data from eco-hydrological monitoring plots, and the Shuttelworth-Wallace two-layer model for sparse vegetation, we compared a control stand and a thinned stand along 4 years. The results varied with the time elapsed since thinning. High evaporative conditions led to high It rates in the control (27% out of gross rainfall, Pg), when comparing with other studies, that were reduced after thinning (50% of basal area removed), so that an additional 15% of Pg reached the soil on average. However, dry canopy ET (T+Es) was clearly higher in the treated plot mostly due to the contribution of Es, which increased from 12 to 20% of Pg after thinning in the overall period. Oaks' transpiration was enhanced with thinning to the point that the stand-water use surpassed that of the control by the second half of the study period, averaging 24% of Pg in both plots. The value Pg-ET(total) in the control ranged 44-285 mm and 19-281 mm for the

treatment, with a net mean difference between both plots of 15 mm/year more in T. According to the overall results, the treatment mostly had a watering effect.

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ID 1048

A GIS-BASED APPROACH TO IDENTIFY THE SPATIAL VARIABILITY OF VULNERABILITY TO FLOODING HAZARD IN TAIWAN

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Owing to the location of Taiwan, the typhoon is the most common environmental hazards. Because of the climate change, both the strength and frequency of typhoon have a significant increase. Typhoon typically occurs during the summer and autumn seasons and is one of the most devastating environmental hazards which causes enormous damage to property and human life. In order to comply the disaster reduction and emergency management, we should understand the spatial variability of vulnerability. In this study, we choose Yilan County as our study area. It is located in the northeastern Taiwan, and often be damaged by typhoons with serious flooding. A Geographic Information System (GIS) approach is applied to identify the spatial variability of vulnerability to the flooding hazards. According to the Water Resources Agency in Taiwan, the flooding potential is a scenario which simulates the certain modes of daily precipitation, physiography condition, and the flood control facilities. The Water Resources Agency provides four different kinds of flood potential maps which are based on the different daily precipitation, 200, 350, 450, 600 mm/day. Through the use of a risk matrix, the classes of a vulnerability map were combined with those of flooding hazard map. Results show that it is important to integrate the vulnerability studies into flooding risk mitigation and emergency management in order to reduce the impact of disasters.

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ID 1051

WATER AND THE CONSERVATION OF WIDE-RANGING FOREST RED-TAILED BLACK-COCKATOOS IN A DRYING CLIMATE

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Spatio-temporal reductions in water availability, due to climate change, are likely to have significant effects on forest fauna, particularly for species that need to drink

regularly, yet are poorly understood,. We investigated how water availability influenced forest fauna by examining the nesting ecology of the threatened, wide-ranging Forest Red-tailed Black-Cockatoo (Calyptorhynchus banksia naso) in the northern jarrah forest of southwestern Australia, a region that has experienced a 25% decline in rainfall in recent decades. We located 156 cockatoo nests across three jarrah forest landscapes and related their spatial location to a range of variables at the hollow, tree, site and landscape scale and compared them to similar hollow-bearing trees that contained no nests. At the landscape scale, we found that nests were no closer to granite outcrops, roads or watercourses than unused trees but were significantly closer to both ephemeral and permanent drink sites, suggesting cockatoos located their nests to increase access to water during their nesting cycle. These results suggest numbers of suitable nesting hollows may decline in the future as reduced water availability renders potentially suitable hollows unsuitable and that the retention of nest trees close to drink sites should be prioritised over nest trees distant from drink sites. We conducted additional work investigating the potential of water as a management tool to offset reductions in water availability by placing artificial water points at various sites in the northern jarrah forest. Preliminary results indicate the artificial water points are utilised by a wide range of forest fauna, including cockatoos. This indicates that the provision of artificial water points appears to be an effective management tool to offset reductions in water availability due to climate change and could potentially be used more widely as a forest management tool to better conserve forest fauna under a drying climate.

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ID 1052

CAMBIOS EN EL USO DEL SUELO: ¿CÓMO ALTERAN LAS TASAS DE INFILTRACIÓN EN EL CENTRO DE ARGENTINA?

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La presión de uso del suelo en el centro de Argentina ha aumentado en las últimas 5 décadas como consecuencia de la habilitación de tierras para el uso agropecuario, industrial o habitacional. Estos cambios, sumados a disturbios antrópicos periódicos tales como los incendios forestales son algunos de los principales procesos de degradación que afectan las características edáficas e hidrológicas de estos suelos, modificando los ciclos hidrogeoquímicos de las cuencas. El objetivo de este trabajo fue determinar las curvas de infiltración y la

infiltración básica de dos órdenes (Molisoles y Entisoles) de suelos bajo diferentes usos y disturbios del suelo en el centro de Argentina. Las mediciones se efectuaron en la Reserva Natural de la Defensa La Calera, donde se concentran diferentes estados de conservación de los suelos. Se realizaron ensayos de infiltración mediante el método del anillo simple. Para los Molisoles se determinaron tasas de infiltración en relictos de monte nativo (MN) y en pastizales con historia agrícola, afectados (PAQ) y no afectados por incendios recientes (PA). Para los Entisoles se determinó infiltración en ambientes de fachinales (comunidades de Vachellia caven y V. aroma) con distinta historia de disturbio por fuego; fachinal no afectado por fuego en los últimos 10 años (FT); fachinal a 4 años de incendio (FQ4) y fachinal con incendio reciente (FQ); éstos a su vez fueron medidos antes y después de las precipitaciones (FQA y FQP). Los resultados indican una relación entre MN/PAQ de 4/1 y entre MN/PA de 7,7/1. En relación a los incendios, la relación entre FT/FQ4 es de 1,3/1, entre FT/FQA de 1,7/1 y entre FT/FQP de 2,3/1. Todas estas relaciones permiten estimar y ajustar los parámetros de escorrentía utilizados en cálculos hidrológicos de la región.

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ID 1055

BIODIVERSIDAD TAXONÓMICA Y FUNCIONAL DE MACROINVERTEBRADOS EN ARROYOS DE CUENCAS INTACTAS E IMPACTADAS DE LA REGIÓN DE AYSÉN

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La Región de Aysén (Chile) se ha mantenido como la más aislada del país, donde la colonización y el desarrollo agrícola fueron insignificantes hasta la segunda mitad del siglo XX. Aunque fue muy afectada por incendios, muchos de estos impactos ocurrieron en altitudes bajas y cerca de la red de caminos. Por ende, cuencas de pequeño a mediano tamaño, junto con muy bajas deposiciones de nitrógeno atmosférico, han estado intactas, pudiendo ser estas áreas de referencia mundial para los procesos de cuencas y ecosistemas fluviales. El objetivo de nuestra investigación fue estudiar la relación existente entre cuencas con bosque primario y la biodiversidad y funcionamiento del ecosistema acuático. Para esto, muestreamos macroinvertebrados bentónicos en 54 arroyos de microcuencas con distintos niveles de intervención, comparando cuencas de bosques primarios con cuencas intervenidas por incendios, deforestación producto de extracción de leña y presencia de ganado. Además, en cada microcuenca se muestrearon y analizaron variables medioambientales locales, variables a nivel de cuenca y variables climáticas regionales. Nuestros resultados indican que las microcuencas con bosque primario difieren significativamente, en biodiversidad taxonómica y grupos funcionales alimenticios, de aquellas con

impactos. Variables climáticas fueron las que mejor explicaron las diferencias en la comunidad de macroinvertebrados entre sitios. Las variables medioambientales locales que mejor explicaron el patrón de biodiversidad también se correlacionaron con el gradiente climático. En las zonas más lluviosas, la velocidad de corriente y heterogeneidad del hábitat fueron relevantes, mientras que las zonas menos lluviosas presentaron mayores concentraciones de nutrientes. Con esto, proponemos que la Patagonia puede ser de los pocos lugares del mundo con cuencas hidrográficas intactas para varios biomas forestales de bosques templados. Se espera que el enfoque de esta investigación entregue información valiosa para una mejor planificación y conservación del uso de las microcuencas en la Región de Aysén.

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ID 1056

CAN WE ASSES FATE OF FORESTED WETLANDS UNDER FUTURE CLIMATE? CASE STUDY FROM CENTRAL EUROPE

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From the forested wetlands perspective the hydric conditions in the habitat are crucial for maintaining their ecological status (e.g. peat forming ecosystems). Climate change is expected to impact the water cycle through changing the precipitation levels, river streamflows, soil moisture dynamics and therefore pose a threat to forested wetlands habitats and thus their biodiversity. The aim of the presentation is to present analytical framework for assessment of potential changes in water supply for both types of forested wetlands: ground water fed (e.g. mire pine forest) and riparian (e.g. alluvial forests with Alnus glutinosa). The case study is located in the river basins of Wisla and Odra Rivers (Central Europe). There were 42 examined locations distributed on area of 280 000km2. Paper examines the past trends and future impacts of climate change on streamflow and soil water content. Simulation results from 1971 to 2000 (historical period) and from 2021 to 2100 (future period) were obtained with the use of the Soil and Water Assessment Tool (SWAT). Hydrological modelling using SWAT was driven by a set of nine EURO-CORDEX Regional Climate Models for a historical period (1971-2000) and two future periods (2021-2050 and 2071-2100). By establishing threshold values of streamflow at bankfull flow flood events were identified. Changes in frequency of the floods informed about the alteration to the water supply for wetlands reliant on inundation. The groundwater-fed wetlands were assessed on the basis of the soil water content. The model outputs were used to develop indices which were calculated for the climate

change scenarios. Comparisons of simulated trends in soil water content and streamflow dynamics with average annual precipitation showed largely consistent patterns. The results show an increase in inundation and soil water content, and this signal was stronger then noise. Most of climate change studies deal with a decrease in moisture therefor this study deals with an opposite projection. An assessment was carried out to identify habitats which might be negatively or positively impacted by climate change. Shows also the gap of knowledge in assessing impact of increasing wetness on wetland forests.

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ID 1064

TRADE-OFFS BETWEEN BIOENERGY EXTRACTION IN BOREAL FORESTS AND SOIL AND WATER QUALITY: A DYNAMIC MODELLING STUDY IN LONG-TERM EXPERIMENTS

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Bioenergy extraction from boreal forests is an important component in climate change mitigation. However, there can be trade-offs between bioenergy extraction and other ecosystem services, e.g soil and water quality. Northern Europe forest ecosystems are to a large extent located on soils with low buffering capacity, and have been exposed to acidifying deposition that has reduced the buffering capacity even more. Whole-tree harvesting in those areas could delay recovery, since harvest residues contain large amounts of base cations. Long-term experiments with whole-tree harvesting have shown that the soil pool of base cations is smaller than after stem harvesting in the first decades, but that the difference and is small or non-existing after 40 years. The processes behind this development are not fully understood, and earlier model attempts have not been able to capture the trend. The aim of this study was to investigate how the nutrient losses after whole-tree harvesting are distributed between soil, water and trees, and to increase the understanding of the underlying processes. For this purpose, the dynamic forest ecosystem model ForSAFE was applied to four long-term whole tree harvesting experiments. ForSAFE dynamically models tree growth, weathering and decomposition, and the feedbacks in between. ForSAFE could reproduce the general development of soil chemistry and the difference between stem- and whole-tree harvesting. The main reason for the reduced difference between stem- and whole-tree harvesting with time was that much more base cations was leached from the soil profile after stem-harvesting. Moreover, the base cation pools in trees and organic material was lower after whole-tree harvesting due to decreased tree growth and decreased amount of organic material. This study shows that ForSAFE has the potential to contribute to the scientific discussion about trade-offs between bioenergy production and soil and water quality in areas with different conditions.

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ID 1065

LACUSTRINE SEDIMENTARY LEAF WAX CARBON DISTRIBUTION ALONG A CLIMATOLOGICAL GRADIENT ON THE WESTERN SIDE OF THE SOUTHERN ANDES

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The climate on the western side of South America is projected to become significantly warmer and drier over the next decades in response to global warming. The magnitude of the expected changes and how these changes in temperature and the hydrological cycle will affect humans are uncertain. Proxies and paleoclimate records are useful to gather data on climate variability which can be compared to climate models and evaluate their performance and help validate future climate projections. A long-term goal of our research is to develop a robust record of climate and environmental change in central-south South America using lake sediment archives. Sedimentary leaf wax derived long chain (>C24) n-alkanes and fatty acids (FA) are among the most long-lived and utilized proxies of terrestrial organic matter. The sedimentary leaf wax carbon distribution (e.g. average carbon chain length, ACL) had been intensively used in paleoclimate studies but recent studies on modern plant have challenged the use as reliable indicators of vegetation without clear controlling factors and region-specific patterns. This study extracted (1-3 g dry weight) plant waxes from 85 core tope lake sediment samples with methanol and methylene chloride and separated them with solid phase extraction column chromatography. The n-alkanes and FA methyl esters were identified on gas chromatography-mass spectrometry (GC-MS QP-5050A Shimadzu) and comparison with standards of each compound, and quantified with GC with flame ionization detection (GC-FID 7890A Agilent Technologies). We compared leaf wax data with latitudinal and orographic climatic trends extracted from monthly gridded reanalysis products of the Climate Forecast System Reanalysis. With some discrepancies between n-alkane and FA, the leaf wax carbon distribution show inflection points at ~42°S latitude and ~1500 m elevation that are likely related to the northern limit of influence of the Southern Hemisphere Westerly Winds (SWW) location and elevation of the snow line, respectively.

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ID 1069
MANAGING TIMBER PLANTATIONS FOR SUSTAINED YIELDS OF CLEAN WATER

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In much of the Southern hemisphere, timber is grown in extensive plantations using exotic species planted into a landscape where they represent a large change in land use. It is clear that substantial increases in biomass to fast-growing timber species can cause marked decreases in streamflow. Management of plantations for multiple objectives, including sustainability and ecosystem services can still be possible though, if the desire and incentive exists. A main incentive is certification for sustainable forest management (SFM). In this paper I outline the important options that ought to be prioritized in certification programmes when both wood and water yields are important. The key is to recognize that good hydrological properties depend on a healthy soil under permanent cover. Designation of adequately-sized riparian reserves, and their rational management to maintain them under stable native vegetation, free from invasive woody weeds and disturbance, is critical. Roads are a necessary evil from the perspective of water quality. A permanent road system that meets high standards of design, construction and maintenance is necessary to protect the integrity of streams. Harvesting methods must prevent puddling of the soils, retain ground cover, and ensure that water is not channeled toward streams. The effects on water yield can be ameliorated by managing the extent of riparian zones and overall planting within drainages, and by manipulating age class distribution and rotation lengths.

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ID 1072
MODELLING THE EFFECT OF VEGETATION AND SOIL ON STREAMFLOW AT A CATCHMENT SCALE

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This study quantifies the effect of different vegetation types and soil characteristics on streamflow in the 15,100 ha Flowerdale catchment, Tasmania, Australia. Catchment water balance was measured and modelled in four sub-catchments: two with areas of 421 ha and 220 ha covered predominantly with Eucalyptus nitens

plantation, one with native forest (dominantly Nothofagus cunninghamii, 179 ha), and one with pasture species (96 ha). Rainfall, streamflow, soil moisture and plantation growth were measured for a period of three years. Streamflow for the entire catchment was been historically measured for more than 40 years. The 3-PG Hydrology model was calibrated and validated for the monitored sub-catchments and applied to the entire catchment to simulate water balance. Soil depth and texture, topography, and vegetation affected monthly runoff coefficient (RC = runoff/ precipitation). Flowerdale has a high average annual RC of 0.53 (range 0.37-0.69) with the RC of pasture and native forest sub-catchments of 0.46 and 0.34, respectively. The shallow soil, higher elevation, Eucalyptus plantation sub-catchment had an RC of 0.37 and mean annual increment of wood growth (MAI) of 10 m3 ha-1 year-1; the deep soil, lower elevation Eucalyptus plantation sub-catchment produced a RC of 0.25 and MAI of 22 m3 ha-1 year-1. The pasture sub-catchment used less water than plantations or native forest under similar conditions of soil and climate at low elevation and led to higher base-flow. Variability of RC and tree growth between the two plantation catchments was explained by landscape and climatic variability. Plantations with higher productivity used more water, and warmer temperatures favoured growth and water use. Daily time-step modelling produced more accurate estimates of discharge (R2 = 0.87) than a monthly time-step (R2 = 0.80). Water use and productivity of vegetation type in the catchment were influenced by soil characteristics and climate, which were adequately simulated simultaneously.

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ID 1073

BUILDING PARTNERSHIPS FOR LONG-TERM WATER MONITORING IN THE SOUTHERN ECUADORIAN ANDES

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High-elevation grassland and forest ecosystems of the Ecuadorian Andes provide critical water provisioning and regulation services for downstream users, yet few efforts exist to document long-term patterns of vegetation change and associated flow dynamics and river morphology. The need for robust and long-term water monitoring is critical in the face of rapid changes in this region. Here, we describe the development of a collaborative forest and water monitoring effort, coordinated by a local non-governmental organization committed to conservation and support of water-dependent livelihoods, in partnership with U.S. and Ecuadorian scientists. Since 2013, we have established monitoring stations to measure streamflow,

sediment fluxes, and channel morphology in the lower Paute River basin in southern Ecuador. Our water monitoring efforts complement a long-standing program of land conservation and reforestation in the area, through partnerships with local landowners. Observations from our monitoring program allow us to quantify sub-annual and inter-annual variability in flow. Repeated measurements of channel morphology demonstrate the dynamic nature of these high-elevation streams and point to important carbon and sediment sources to downstream receiving waters. Monitoring data associated with our reforestation program allow us to make inferences about success rates depending on landowner buy-in and maintenance of reforested parcels. In this presentation, we focus on our strategies to build effective partnerships, make data publicly available for decision making, and engage and educate local stakeholders on our work.

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ID 1076

STREAMFLOW RESPONSE TO THE CLIMATE CHANGE AND HUMAN ACTIVITIES: FROM WATERSHED STUDIES TO GLOBAL ESTIMATION

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It is the first step to partition the streamflow response to climate change (dQ_CC) and human activities (dQ_HIC) for understanding the forest water relations under changing environment and complex watershed conditions. We used eco-hydrological approach, elasticity differential analysis and physically-based MIKESHE model to partition the distinctive contribution ofclimate variability and landuse change to the decadal streamflow changes for a watershed located in northern China. Our result indicated that compared with the reference period 1963-1979, the streamflow greatly decreased during 1980–1989 and 2000–2008, whilst it slightly changed during 1990–1999. The impacts of climate (dQ_CC) and landuse(dQ_Landuse) for 1980–1989 and 2000–2008 were different as derived by different approaches. By taking into account the errors of each approach, a general consistent results could be arrived. Further, we conducted meta-analysis of 103 studies to derive streamflow change by climate and human activities at global scale. We found that streamflow over the past seven decades (~1930s to 1990s) generally decreased, by a mean of -11.9 mm.a-1. Climate changes, on average, induced streamflow increase (i.e., mean dQ_CC = +3.6 mm.a-1), with a varying pattern from positive at early century gradually to negative at late century; whilst human activities decreased streamflow (i.e., mean dQ_HIC = -15.5 mm.a-1). The great variability of dQ_CC estimations was due to the dominate role played by climate type as a strong relationship between the absolute depth dQ_CC and P was observed. Over the past decades, the magnitude of the depth dQ_CC was generally varied from 27 mm a-1 to over 100 mm a-1 for moist area (i.e., > 800 mm a-1), whilst it varied from around 15 mm.a-1 to almost zero when < 600 mm a-1. We

concluded that It is possible to make dQ_CC predictions on the global scale in the future by using the established relationship between dQ_CC and dP.

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ID 1088

STAND-SCALE ESTIMATION OF THROUGHFALL AND STEMFLOW FOR JAPANESE CONIFEROUS PLANTATIONS

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Forest water input (throughfall: TF plus stemflow: SF) affects the eco−hydrologic tradeoffs in forested ecosystems. Therefore, it is crucial to balance human and ecosystem water needs. Developing the practical model of forest water input can be useful to enhance ecological services including water resources. Although there are several models for coniferous TF estimates using stand structures, there are no models for coniferous SF using stand structures despite that SF cannot be neglected as forest water input. Thus, it is necessary to develop a forest water input model in the estimation of TF and SF simultaneously in order to better understand the changes in environment and water resources control. The objectives of this study were (1) to examine the relationships between forest water input and stand structures and (2) to develop its practical models. To examine influences of stand structures on TF and SF, we collected 34 rainfall partitioning data of Japanese coniferous forests. Two steps for analysis were conducted using Pearson correlation and multiple-regression analyses. The results demonstrated that TF was correlated with stand density (SD), height (H), diameter at breast height (DBH), and canopy cover (CC) ($P < 0.05$), and SF with SD, H, DBH, CC, and basal area (BA) ($P < 0.05$). Furthermore, two simple models of TF and SF by adding and/or excluding the related stand structure variables were developed based on the adjusted determinant coefficient. The resulting predictive variables were SD alone for TF and SD and BA for SF. These models showed good predictive performance, with RMSE being 4.6 % for TF and 2.3 % for SF. Our results would help better understanding of changes in forest water input and guide ecological services by the models using easily obtained data of SD and BA.

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ID 1089

RAINFALL PARTITIONING IN UNMANAGED-OVERSTOCKED DENSE CONIFEROUS PLANTATIONS WITH A NUMBER OF DEAD BRANCHES

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The climate change is broadly considered to have an impact on the temporal distribution of precipitation in the region of Central Europe. It is expected that this will result in more frequent occurrence of extreme events such as floods and droughts. Forests are considered as a very important for the runoff from small to medium catchments as they can help to mitigate the impact of the climate change. Another measure, which is considered as very important in the Czech Republic, is building of small water reservoirs, which should help the retention of water in the landscape. This is in the focus of the research project NAZV KUS QJ1620395 "Restoration and building of ponds in forest areas as a part of sustainable water resources management in CZ". One of the project tasks is the investigation of influence of forests on the hydrologic regime. The main question is, how the presence of forests influences the runoff conditions. In this contribution, the influence is investigated using the assessment of the relationship between the percentages of forests and selected characteristics of runoff in 28 catchments up to 150 km2 in the Czech Republic. As runoff characteristics, mainly the runoff coefficients and the shape of the recession limbs of selected significant rainfall-runoff events were identified through the analysis of discharge time series. The results of such analysis indicate the influence of forests on the runoff regime which is however affected by the influence of other factors. The results will be helpful in the planning of new small water reservoirs to be built in forest areas, which can support the management of water.

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ID 1093

HYDROLOGICAL EFFECTS OF FOREST VEGETATION IN WATERSHED RESTORATION IN SERBIA

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Climate change modifies the amount and spatio-temporal distribution of precipitation in Southeastern Europe, causing frequent torrential floods. Effective protection from erosion and torrential floods encompasses biological and biotechnical works on the slopes in the watershed and technical works in the torrent

bed. The analysis of effects of performed erosion and torrent control works (ETCWs) at three experimental watersheds in southern Serbia is presented in this paper. Restoration of the watersheds was performed primarily on the basis of afforestation of bare lands and partly with torrent training works. Land use changes were analyzed on the basis of data collected from 1927 to 2016, field investigations, usage of satellite photo images and topographic maps. Area sediment yields and intensity of erosion processes were estimated on the basis of the "Erosion Potential Method". The changes of hydrological conditions were estimated by the comparison of the historical and computed values of maximal discharges, in the conditions before and after the restoration of the experimental watersheds. Historical maximal discharges were reconstructed by the method of "hydraulic flood traces". The computation of maximal discharges was performed using synthetic unit hydrograph and Soil Conservation Service methodology, based on the regional analysis. The content of organic matter was determined on the basis of soil analysis from experimental and control sites. The intensity of erosion processes has been reduced from excessive to weak erosion. Former bare rocks were transformed into forest surfaces or transitional wood-shrub land. Sediment yield has significantly decreased as well as maximal discharges and volumes of direct runoff hydrographs, due to the performed ETCWs. The aim of this research is to show how performed ETCWs, as well as adequate land use changes, which are based on the afforestation, can help to improve the hydrological conditions on endangered watersheds, and provide effective erosion and torrent control.

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ID 1094
INVESTIGATING THE IMPACT OF TREES AND HEDGEROWS ON LANDSCAPE HYDROLOGY

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Deforestation for agriculture coupled with changes to the intensity and frequency of rainfall events brought about by climate change, presents flood risk challenges for temperate zone countries. Traditional hard-engineered flood defence infrastructures are failing to keep pace with changing environmental conditions, whilst the cost of building and maintaining new infrastructure can be both prohibitive and undesirable. Consequently, natural flood risk infrastructure, such as tree planting, is gaining significant interest as an alternative approach to flood mitigation. Whilst much attention has been given to hydrological impacts of catchment afforestation, the effects of small tree features such as shelterbelts on downstream flooding is poorly understood. Here, we specifically examine how trees and hedgerows influence soil hydraulic properties and processes and quantify the species-specific role of trees in flood mitigation. To determine the effects of tree

species on soil hydraulic properties, root cores were sampled alongside in-situ hydraulic conductivity measurements in the BangorDIVERSE tree diversity experiment located in Abergwyngregyn, United Kingdom (53°14'15"N, 4°1'4"W). Root biomass and morphological characteristics were determined at three depths (0-10 cm, 10-20 cm and 20-30 cm) from single tree species plots of Alnus glutinosa, Betula pendula, Fagus sylvatica, Fraxinus excelsior, Acer pseduoplatanus, Castanea sativa and Quercus robur as well as from two tree species mixtures of B. pendula – F. excelsior and C. sativa – B. pendula. Species identity had a significant impact on root biomass and morphology that was strongly correlated to soil hydraulic properties. Spatial optimisation and strategic species-specific planting of trees and hedgerows in the landscape offers potential to maximise the hydrological benefits of trees for flood mitigation, whilst maximising the land available for agricultural production.

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ID 1095
RETENCIÓN DE AGUA EN OBRAS DE CONSERVACIÓN DE SUELO EN ZONAS ÁRIDAS Y SEMIÁRIDAS.

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La deforestación de formaciones xerofíticas en la zona árida y semiárida ha causado problemas de desertificación, cambiando los regímenes de escorrentía y en general diversas funciones y servicios que prestan estos ecosistemas. El diseño de obras de conservación de suelo (OCS) orientadas a la retención de agua proveniente de las precipitaciones, ha sido materia de discusión y propuestas de manejo por parte de diversas instituciones en Chile, sin embargo, no ha existido una evaluación de eficiencia de estas obras en relación a la cantidad de agua retenida términos espaciales y temporales. Este estudio busca conocer el comportamiento de tres OCS (Limanes, Surcos en media luna y terrazas de piedra), evaluando el contenido de humedad del suelo (CVA m3/m3) a distintas profundidades y su relación con una condición natural. Los resultados muestran que las OCS incrementan el contenido de humedad, principalmente a los 30 cm de profundidad. El caso de los Surcos, estos registraron el mayor contenido de humedad durante el 2017 (0,55 m3/m3), sin embargo, el promedio de CVA fue mayor a los 60 cm. En términos generales los Surcos en Media Luna son los que en promedio presentan una mayor CVA que el suelo natural. El uso de estas OCS, están financiadas en parte por el programa de recuperación de suelos SIRSD, administrado por INDAP y SAG, sin embargo, no se financia el establecimiento de plantas dentro de estas obras y han sido poco estudiadas en cuanto a la conservación de suelo y agua que realizan.

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ID 1096

MANAGEMENT PRACTICE'S PERFORMANCE IN IMPROVING INFILTRATION PROCESS ON AREAS UNDER ACTIVE RESTORATION

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Silviculture practices have been adopted to improve trees growing on forest restoration process, mainly when performed on degraded areas. In this case, silviculture operations are required to guarantee restoration success besides high cost, hence the search for restoration using as less interventions as possible. However, the effect of these techniques on ecosystems processes related to water has been poorly studied. One of important processes expected to be improved is infiltration, that represents the input of water in the soil system. We studied the infiltration processes on an active restored area of Atlantic Forest (14 years) at southeastern Brazil. We tested the management factors (usual-U and maximum-M), differentiated by chemical weeding in the M; and tree densities (3,333 seedlings/ha and 1,667 seedlings/ha). Furthermore, measurements were taken on pasture, which is the previous use, and in areas without intervention isolated from trampling cattle, considered control. We used the BEST method (Beerkan Estimation of Soil Transfer parameters), that apply field experimental data and soil texture to estimate the Saturated Hydraulic Conductivity (Ksat). Even though it was a sandy soil, the pasture presented values of Ksat lower than all other treatments, including the control, probably due to strong effect of cattle trampling on soil compaction. The control presented values slightly lower than forested areas, which could be interpreted as an effect of the natural regeneration. There was no significant difference between the forested areas, except for areas with usual management/3,333 seedlings/ha and maximum management/1,667 seedlings/ha. Results are discussed in relation of forest inventory data in order to understand effects of forest growing infiltration.

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ID 1099

FOREST BIODIVERSITY, CLIMATE CHANGE AND URBAN WATER SUPPLY IN THE UNITED STATES SOUTHEAST

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The North Carolina Research Triangle is among the most rapidly growing metropolitan areas in the United States, with decentralized governance split among several different municipalities, counties and water utilities. The growth of water demand with rising populations with typical suburban sprawl, the development of multi-use reservoirs immediately downstream of urban areas, and increased hydroclimate variability have raised the potential for periodic water scarcity coupled with increasing eutrophication of water supplies. While urban areas are expanding in their own water supply catchments, the dominant land use is still forest, which significantly expanded in the 20th century following agricultural abandonment. The regrowth forest is dynamic and heterogeneous in water use based on age class and species distribution, with substantial plantation and natural regeneration. More recently, the unmanaged canopy appears to be shifting to greater representation of anisohydric compared to isohydric species, with further implications for forest water balance and reservoir recharge. Forecasts of land use and forest structural and compositional change are based on scenario socioeconomic development, climate change and forecast wood product markets. We discuss the interactions and tradeoffs between management of emerging water scarcity, quality, forest extent and biodiversity in the Triangle as a model for the US Southeast. We emphasize principles of ecohydrologic resilience learned in heavily instrumented research watersheds, adapted to rapidly developing urban systems, and including socioeconomic and policy dynamics.

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ID 1102

SOIL MOISTURE DECLINE FOLLOWING THE PLANTATION OF ROBINIA PSEUDOACACIA FORESTS: EVIDENCE FROM THE LOESS PLATEAU

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Soil moisture is the foundation of ecosystem sustainability in arid and semi-arid regions, and the spatial–temporal details of soil moisture dynamics of afforested areas can benefit for land use management in water shortage regions such as the Loess Plateau of China. In this study, spatial–temporal variations in soil moisture under Robinia pseudoacacia plantations on the Loess Plateau were analyzed. A total of 147 observations of soil moisture content (SMC) data to a depth of 500 cm soil profile were collected in 23 counties via field transect surveys and analyses of published literature. The results suggested that (1) the depth-averaged SMC was generally lower under forest sites than under cropland, both in the shallow layers and in the deep profiles. This finding implied that, compared with the native vegetation, the introduced R. pseudoacacia plantations caused intense reductions in soil moisture. (2) SMC was positively correlated with climatic factors (mean annual precipitation (MAP), mean annual temperature (MAT), and the Palmer drought severity index (PDSI)), indicating that the SMC under R. pseudoacacia plantations was highly

consistent with the hydrothermal conditions at the regional scale. (3) The decreasing amplitude of SMC was linearly related to the increasing number of restoration years, especially in the areas below the 500–550mm precipitation threshold. This finding showed that the restoration ageing sequence was an influential factor that affected the regional SMC variation in R. pseudoacacia plantations on the Loess Plateau. Our results suggest that afforestation activities should be avoided if the local total precipitation is insufficient for replenishing the soil moisture and that local tree species with a lower demand for water resources should be considered a top priority for further afforestation of the Loess Plateau.

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ID 1108

TEMPERATE FORESTS AS ECOSYSTEM REFERENCES FROM THE WATERSHED PERSPECTIVE IN SOUTHERN CHILE

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Forests with limited human intervention are diminishing feature in modern landscapes. They are as essential in terms of conserving biodiversity, or as reference systems, for forest management/restoration and also for associated stream ecosystem function, hydrology and morphology. In Patagonia, some of the largest remaining intact watersheds are in close proximity to watersheds that are heavily impacted from recent fires, clearing and grazing activities, a pattern extending across several forested biomes. In order to understand baseline conditions and general changes to the stream ecosystem from recent land alterations, we compared forest structure, woody debris and stream ecosystem function of paired reference vs. impacted small watersheds (2-5 km2), for 2 pairs of deciduous (precip. 800-1200 mm/y) and 2 pair of evergreen watersheds (precip. 1500-2000 mm/y). The evergreen forests reference sites had more frequent channel debris of smaller mean diameter compared to the impacted sites. Deciduous reference watersheds had younger woody debris but otherwise very inconsistent patterns within sites and across pairs. There was a significant relationship between stream woody debris density and the frequency of log jams across all sites, with a stronger effect in deciduous forest. We also report on preliminary results from corresponding stream ecosystem assessments (metabolism, cellulose degradation, nutrient assimilation and hydrology) all of which are expected to be influenced by woody debris. Despite very clear differences in land use across pairs (e.g. complete transformation of forest to grazing land for evergreen biomes, or evident soil loss and alteration of forest structure for deciduous sites) our observations suggest a much more subtle

and complex relation between forest structure, and stream ecosystems. The latter in turn may be influenced by legacies of previous forest structure, natural disturbance and stream channel changes, and perhaps most importantly the specific forest management activities.

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ID 1109

MODELLING THE EFFECTS OF CLIMATE CHANGE AND NITROGEN FERTILISATION ON NITROGEN LEACHING AND FOREST SOIL ORGANIC CARBON

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Understanding of nitrogen (N) cycling is important in designing a sustainable forest management. There is an ongoing debate in Sweden regarding N fertilisation of forests. At present it is not recommended to fertilise in the southwestern parts, where the deposition of N has been elevated in recent decades, but opinions differ. Fertilising can potentially lead to higher tree growth and higher carbon (C) sequestration in trees and soil organic carbon (SOC), but could also lead to an increase of N leaching and eutrophication. In this study, the dynamic forest ecosystem model ForSAFE was used to study the effects on three managed forest sites in different climate zones in Sweden; Västra Torup in southern Sweden, simulated earlier for other types of forest management scenarios by Zanchi et al. , with signs of N saturation; Södra Averstad in midwest Sweden with a historic high N deposition and Högbränna in north of Sweden, with historically low N deposition. Changes in SOC and N leaching were investigated in response to modelled N fertilisation, clear-cuttings and thinnings over several rotation periods. Forest sites with signs of N saturation are likely to leach N in the future in response to N fertilisation. Simulations over several rotation periods shows a decreasing trend in both tree growth and SOC, as a result of climate change increased temperature coupled with summer droughts. Increased water stress will limit growth and uptake, lowering the ecosystem's N retention and thereby increasing N leaching.

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ID 1111

EFFECTS OF ENVIRONMENTAL CHANGE ON WATER AVAILABILITY OF A TROPICAL MOUNTAIN WATERSHED IN COLOMBIA

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The assessment of land use/land cover change (LUCC) and climate change effects on water availability are key to water resources management and conservation, especially in tropical mountain regions, where water supply for a large portion of the population depends on surface water availability. An example of these kinds of river watershed is the Chico river watershed (CRW) located in central Andes of Colombia. This watershed is strategic as it supplies water for the Metropolitan Area of Medellin (the second largest city in the country with 4 million people); is an important producer of dairy as well as other agricultural products; and the generation of hydroelectric power. The CRW has an area of 169 Km2 with altitudes ranging between 2.405 and 3.264 m.a.s.l., mean annual temperature of 15 °C and mean annual precipitation of 1.820 mm. Ecologically, the upper portion of the watershed corresponds to endemic paramo ecosystems associated with native Andean forests. The transformation of these natural ecosystems into croplands and pasture for dairy cattle raising, in combination with intensified interannual climate variability phenomenon as the El Niño - Southern Oscillation (ENSO) may threaten CRW ecological and hydrological stability with consequences for ecosystem services, including water supply for people. In this study, we implement the Soil and Water Assessment Tool (SWAT) model to assess the potential impacts of LUCC and intensified (more frequent) ENSO events on water availability in the CRW. Our results illustrate how increased land use transformation impacts to water availability, especially under El Niño conditions. These results highlight the strategic role of forest cover to mitigate reductions in low flows due to intensified El Niño events. Further, our results provide insights for decision-making in land use and water resource planning in strategic watersheds.

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ID 1113

THE ZERO-SUM OF CLIMATE CHANGE ON FOREST ECOSYSTEM PROCESSES

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Climate change is bringing substantial increases in air temperature in Scandinavia. Recent studies have suggested a correspondingly important gain in

biogeochemical processes, leading to expectations of strongly higher biomass growth. The net increase in growth is explained by longer growing periods, sustained by accelerated nutrient release processes. Yet, while climate change is not expected to change the annual amount of precipitation in Scandinavia, there is mounting field evidence, supported by global climate model simulations, of increasingly drier summers. The present study tests the hypothesis that drier summers will cancel out the expected positive effects of higher temperatures on forest growth in Scandinavia. The study uses the integrated forest ecosystem model ForSAFE, together with a database of 640 forest sites from the Swedish National Forest Inventory, to simulate the simultaneous responses of soil biogeochemical and tree physiological processes to downscaled climate change scenarios. The results indicate that a substantial fraction of the simulated forest stands will experience increasingly severe water shortages between the months of June and August, resulting in lower growth rates but with no significant effect on soil carbon stocks. More frequent precipitation peaks early in the growing season will lead to higher rates of nitrogen leaching, and to a lesser extent DOC and base cation leaching. The net negative effect is mostly limited to the southern, south-eastern and eastern coast regions of Sweden. In contrast, the northern parts of Sweden will benefit the most from climate change. A distribution of net gains and losses over the 640 simulated forest stands indicates an insignificant positive contribution of climate change to forest growth in Sweden. These results raise questions about the viability of increasing production expectations put on Swedish forests in the ongoing effort to substitute fossil fuels.

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ID 1116

THE REGIONAL POLITICAL ECOLOGY OF FOREST AND WATER USE AND ITS RELEVANCE FOR THE GLOBAL DEVELOPMENT GOALS OF AGENDA 2030: A COMPARATIVE APPROACH TO CASES IN CHILE, SWEDEN AND THE US

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This paper uses a regional political ecology approach to examine issues of power and regulation implied in the use of water and forest resources in Chile, Sweden and the US. This unique and novel comparative study allows identifying key contextual factors interplaying in how water and forest resources are managed in regional areas within these three countries. Within this context, the paper has two interrelated objectives: First, the paper aims at showing and discussing the role that legal frameworks play in three regional case studies and why legal differences are of crucial importance in the explanation of both conflicts and conflict management

concerning the use of water and forest resources. Secondly, the paper shows and discusses how power relations concerning the use of forests and water are contested at different levels and scales in the three countries. The previous discussion serves to argue that understanding how power relations and legal and extra-legal regulations define the possible local uses of forest and water resources is crucial to fully identify key social-ecological challenges for achieving the goals of Agenda 2030 at the national level. The paper is based on doctoral and post-doctoral research carried out by the paper´s author, which included extensive fieldwork in study areas in Chile (the Ñuble Province); Sweden (Middle Norrland); and the US (The Delaware County and Catskill Mountains in New York State). Thus, the empirical material supporting the main arguments of the paper consists of more than 60 interviews, multiple site observations in the three countries and the analysis of hundreds of documents produced by different actors with interests in forest and water resources in the three countries. The paper concludes with a comparative assessment of the political ecology of water and forest use in the context of the global development goals of Agenda 2030.

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ID 1118

LOCAL PERCEPTIONS OF BENEFITS OR LOSSES FROM EUCALYPTUS AND PINE PLANTATIONS IN CAJAMARCA AND ANCASH, PERU.

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With the goal to determine the environmental and socio-economical viability of planting Eucalyptus and Pines in the Peruvian Andes, a Likert scale survey was applied to 320 rural inhabitants at the Cajamarca and Ancash Regions, Northern Peru. Consultations dealt with the plantation influences on water quality and quantity, soil conservation, erosion processes, agricultural crops, native flora and fauna species, economic gains from wood and different to wood forest products and ecotourism, local weather, fire risk, and carbon capture. At present, the field work was already finished, the data processing is being carried out, and the final results are expected to be ready in a few weeks. Cajamarca and Ancash, as well as other Andean Regions, show increased trends to grow Eucalyptus and Pines, however the environmental concerns about planting exotic species persists, specially related to the local water requirements, and the great differences in water availability in the Northern and Southern Peruvian Andes. The study is supported by SOCODEVI, from Quebec, Canada.

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ID 1122

BLUE TARGETING: A SIMPLE TOOL FOR PLANNING OF BEST MANAGEMENT PRACTICE (BMP) FOR FORESTRY ALONG SMALL STREAMS

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Forestry affect freshwater ecosystems and therefore there is a need of water protection in forestry. Good planning may minimize the impact of forestry operations. Blue Targeting (BT) is a simple tool for best management practice (BMP) for forestry along small streams. The tool was developed by WWF Sweden in cooperation with forest companies and other forestry actors. It was constructed for small streams (width approx. <10 m) as these are most vulnerable. The tool was made for boreal conditions, but it can rather easily be adapted to streams in other biomes. The strength of BT is its simplicity, which means that it can be used by non-technical stakeholders after a day of training. BT is actively used by Swedish forest owner's associations to optimize water protection measures. Blue Targeting consists of two steps. (1) Description of stream sections, including riparian zones, and assessment of Conservation value (C), Impact (I), Sensitivity (to forestry operations, i.e. risk of siltation of bottom substrate) (S) and Added value (e.g. cultural remains, sport fishing arrangements). This is done by field inventory using the standardized CISA check list which consists of binary (yes/no) questions (parameters) and a score system. (2) The scores of the CISA survey are then used to rank the stream section into one of four "Blue Target classes". For each class there are recommendations on appropriate riparian buffer zone management, how to cross the stream, addition of dead wood etc. The results may be shown at maps. Results from analysis of the relations of CISA/Blue Targets to water chemistry and fish assemblages are presented and discussed.

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ID 1123

RECOVERING SOIL INFILTRATION CAPACITY ALONG 50 YEARS OF NATURAL REGENERATION ON ATLANTIC FOREST PATCHES

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Natural forests are recognized for providing optimal soil infiltration conditions, what is probably related to nutrient cycling, microclimate under canopy and forest ecological processes interactions along time. At Atlantic forest, after deforestation and intensive cycles of agriculture on tropics, land abandonment has been allowed natural regeneration on less productive areas, what created small patches of secondary forest under succession process. In most of Atlantic Forest biome, these forests are recovering essential ecosystem functions as soil permeability, wherein infiltration is a key process that directly affects the terrestrial phase of hydrological cycle. However, the time required for processes recovery in secondary forests is still poor studied. We assessed infiltration rates using Beerkan Estimation of Soil Parameters through Infiltration Experiments, referred as BEST. The study was conducted in a pasture matrix landscape on Atlantic Forest patches in São Paulo State, Brazil. Measurements were taken on forest plots at four different times of natural regeneration, as well on pasture and on an old-growth forest, considered as reference. Until at least 21 years, the infiltration rates were lower than the mature forests, but already higher than pasture. We found similar infiltration rates to the reference from 21 years of regeneration, but there is a trend to increase rates overtime. Pasture presented values lower than all other areas, highlighting the effect of past land-use and the present cattle trampling on soil compaction. The relationship of forest structure and organic matter decomposition on soil are discussed based on observed field data. FAPESP Process 2015/23719-6

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ID 1130

HIDROLOGÍA DE CUENCAS DE CABECERA CON BOSQUES EN ESTADO INICIAL: COMPARACIÓN ENTRE VEGETACIÓN NATIVA Y EUCALIPTO

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Ante un panorama de incertezas respecto a las relaciones existentes entre bosques establecidos con restauración de especies nativas y los procesos hidrológicos, sumado al desconocimiento sobre estas relaciones durante la etapa inicial, en comparación con plantaciones forestales; se estableció un monitoreo hidrológico en Municipio de Itatinga, Sao Paulo, Brasil; para evaluar y comparar la dinámica hidrológica superficial y subterránea en dos microcuencas, durante un año hidrológico bajo coberturas diferentes, la primera con plantación forestal y la siguiente con restauración de vegetación nativa, ambas en estado inicial. Para esto cada microcuenca cuenta con una estación limnigráfica, un vertedero, un pluvuiógrafo y dos pozos piezométricos. Para procesar los datos se realizó el balance hidrológico y se analizaron sus componentes, luego se comparó el ciclo anual de precipitación y de caudal, se aplicaron filtros digitales y se determinó caudal base, se estimó la evaporación usando ecuaciones empíricas, se

efectuaron ensayos de infiltración para determinar la conductividad hidráulica del suelo, finalmente, aplicando la metodología: "The water table fluctuation" (WTF) se estimó la recarga subterránea, para cada cuenca. Se analizó comparativamente entre las cuencas las variaciones existentes en procesos de: Evapotranspiración, aporte de escorrentía directa, infiltración del agua en el suelo y recarga de agua subterránea. Identificando, que la cobertura de restauración favorece tasas de recarga en respuesta a eventos de lluvia, observando mayor magnitud en relación a la cuenca de plantación; además la recarga presenta una alta variabilidad bajo vegetación riparia en contraposición a la identificada bajo la cobertura manejada. Adicionalmente se determinó que el caudal presenta una respuesta rápida a los eventos de precipitación contrario a la recarga que respondió a una velocidad menor, presentando un rezago temporal; evidenciando que el uso de la tierra influencia el ciclo hidrológico, como también al tiempo de residencia del agua en las cuencas.

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ID 1131

IMPACTOS DE LA GANADERÍA Y LA TALA SOBRE LOS BOSQUES NATIVOS DE CONSERVACIÓN Y EL SERVICIO ECOSISTÉMICO DE CALIDAD DE AGUA A ESCALA DE CUENCA

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Los efectos de las actividades antropogénicas sobre los bosques nativos de conservación han generado impactos sobre sus servicios ecosistémicos y la conservación del agua en cantidad y calidad. Sin embargo, en Chile aún no se han realizado estudios que evalúen el grado de impactos de las intervenciones madereras (tala) y la ganadería en los bosques cercanos a los cursos de agua, definidos como bosques de conservación por Ley 20.283. Se seleccionaron 12 cuencas distribuidas en las unidades geográficas costa, valle y andes de la región de los Ríos, Chile, para evaluar el impacto de la ganadería y tala sobre la estructura y composición de los bosques nativos de conservación y suelos en zonas ribereñas y los efectos sobre la calidad del agua a escala de cuenca, medido a través de nutrientes y materia orgánica disuelta en sus diferentes formas. Mediante análisis de componentes principales se identificaron cuencas símiles/disímiles entre sí y exploraron los factores que expliquen esta similitud o agrupamiento. A través de análisis de Correlación Múltiple se determinaron cuáles fueron son los principales impactos de la actividad antrópica en cuanto a la degradación del bosque y el servicio ecosistémico de calidad agua. En base a estos datos se hacen recomendaciones de manejo y del marco legal para los bosques nativos de Conservación y Protección y la provisión de agua como servicio ecosistémico. Información útil para instituciones gubernamentales y no gubernamentales, propietarios de bosque nativo y comités de agua potable rural.

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ID 1133

UNDISCIPLINARY THINKING NEEDED TO MANAGE RISKS TO BOREAL WATER RESOURCES AS CANADA TRANSITIONS TO A LOW CARBON FUTURE

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The policy landscape is changing as Canada works towards reducing greenhouse gas emissions by 80% over 2005 levels by 2050. Within the Boreal Zone this policy objective will bring new challenges. The Boreal Zone has already been designated at risk due to the cumulative effects of intensifying natural resource activities (forestry, mining, oil and gas, and renewable energy) on water resources in the face of the uncertainty associated with climatic variability and climate change. As Canada shifts from an oil/gas/coal producing country to a renewable energy leader, there will be additional challenges to ensure that we do not further disadvantage marginalized communities living in the Boreal Zone who are at high risk of the consequences of climate change. In response to these challenges, the Boreal 2050 project was initiated to understand the risks of failing to achieve the policy objective using the ISO 31000 risk management framework. First, we identified the major drivers of the risks for the Boreal Zone, which include atmospheric change, demographics and societal values, governance and geopolitics, innovation and infrastructure, and the demand for provisioning and non-provisioning ecosystem services. Second, we analyzed these risks using scenario analysis where we framed four plausible future scenarios around two axes of change: the global economy's energy and society's capacity to adapt. Third, we evaluated the risks and determined that present governance systems are driving Canada towards failing to meet the policy objective. To meet the policy objective, we need to shift from a top-down command-and-control strategy where Canadians have a low capacity to adapt, towards a bottom-up participatory strategy where Canadians – particularly Indigenous communities living in the Boreal Zone – have a higher capacity to adapt. To facilitate this shift in governance, substantive changes in institutional arrangements designed to protect Boreal Zone water resources will be required.

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ID 1135

REPLANTING LIFE: ECOLOGICAL RESTORATION AS A TOOL FOR SOCIAL INCLUSION AND INCOME GENERATION FOR PRISONERS

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The United Nations (UN) presented 17 goals for the world sustainable development until 2030, among then is the reduction of inequality, the offer of decent work and economic growth, protection of life on land and bellow water to halt and revert the planet degradation. The Socio-Environmental Program "Replantando Vidas" (Replanting Lives), conducted by the Water and Sewage State Company of Rio de Janeiro (CEDAE), have been contributing for the achievement of these goals by using prisoners workforce in the ecological restoration. This paper aims to present the Replanting Lives Program and its contribution to achieve the sustainable development goals proposed by UN. Some of the policies of UN to reduce inequalities are social inclusion, income generation, empowerment and guaranty of equal opportunities to marginalized populations. The Replanting Lives offers decent work opportunities to inmates of the state prison system in activities related to restoration and protection of riparian ecosystems and other areas of interest for recharge and quality of the water destined to urban supply. Currently, CEDAE employs 346 prisoners in different work fronts, one third of this contingent is employed in environmental related activities. The prisoners receive professional training, national minimum wage, meal and transportation allowance and remission of one day of imprisonment for every three days worked. The prisoners works in activities such as collection of native trees seeds, production of seedlings, reforestation planting and maintenance. These activities promote the mental and physical strengthening of the prisoners, stimulates group work and present new perspectives of life with positive impact in the reduction of criminal recidivism. In addition to the restoration of natural ecosystems and the social inclusion of prisoners, the program also promotes partnerships between different institutions, since it have initiatives in more than 70 municipalities in the Rio de Janeiro state.

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ID 1146

USING LEAF AREA INDEX AS A DECISION VARIABLE FOR OPTIMIZING WATER YIELD ON PINUS RADIATA PLANTATIONS IN CHILE

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Intensive forest management of radiata pine (Pinus radiata D. Don) plantations in Chile has been focused on increasing stem volume production and maximizing revenue. Nevertheless, increasing drought, in addition to emerging conflicts with neighbour communities regarding water use in the watersheds, have opened the discussion about the sustainability of forest plantations, with emphasis in the general water balance. This is particularly true in the context of the predicted lower rainfall and increasing temperatures expected during this century in many regions of Chile under future climate scenarios. Base on that, in this study we explored the inclusion of a critical Leaf Area Index (LAI) needed to attain a desirable water yield (WY) as an alternative decision variable for managing planted radiata pine in Chile. The 3-PG model (Physiological Processes Predicting Growth) was parameterized and validated for radiata pine plantations using the approach proposed by Gonzalez-Benecke et al. (2014 and 2015), including a new module that allows for thinning based on threshold upper and residual LAI. We tested the use of LAI in terms of WY and volume production. Thirty site conditions in Chile were selected, including different soils and climate across the distribution of planted forests in Chile. Using the newly parameterized 3-PG model, yearly LAI, WY and stem volume yield were computed for each site. Then, some critical or desired values of water yield (40%, 60% and 80% of total annual rainfall) were tested, and the mean LAI that can support this WY were obtained for each site. We determined the relationship between mean annual LAI and WY on sites with different water deficit. We also determined the trade-off between WY and stand volume yield at age 22 years. We demonstrated that LAI and water yield can be considered in future management for radiata pine plantations.

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ID 1150

FUNCTIONING OF ENDANGERED FITZROYA CUPRESSOIDES RAINFORESTS UNDER DROUGHT STRESS

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The temperate rainforests dominated by the giant Fitzroya cupressoides (Alerce) in the Pacific coast of southern Chile are among the longest-lived (>3600years) and highest biomass forests (>450 Mg C/ha) in the world. Changes in the mid-latitude westerly jet are exposing these rainforests to progressively drier summer conditions. Widespread tree and crown mortality during increasingly severe droughts have raised concerns about the persistence of these rainforests under a regional scenario of continued summer drying projected by climate models. We will present novel insights on how sensitive is the functioning of Alerce rainforests to drought in our long-term monitoring site at the Alerce Costero National Park. This site is equipped with an Eddy-covariance tower and an array of sapflow probes and dendrometers that provide simultaneous measurements of ecosystem (top-down) and tree-level (bottom-up) evapotranspiration, stem growth and micrometeorology at a time step of 30 min. We will discuss how the mechanistic insights obtained from this site can be integrated with ecosystem models to project the possible responses of Alerce rainforests to continued summer drying in the coming decades.

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ID 1157

RESTORATION OF THE HYDROLOGICAL FUNCTIONS ON THE UBATIBA RIVER WATERSHED IN THE CITY OF MARICÁ, RIO DE JANEIRO, BRAZIL

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The Ubatiba river watershed is the main source of water supplying the city of Maricá, located in the coastal lowland region of the Rio de Janeiro state. This watershed has large deforested areas explored with farming and also pressures for urban occupation. Its rivers have few riparian forest, unprotected floodplains and degraded pastures, which reduces the water infiltration and storage capacity. The watershed have less then 50 km², being classified as small and having hydrological sensibility, which means that it is capable of responding to uses and interventions.

The project presented in this paper intent to restore the hydrological functions of the Ubatiba river watershed applying physical and biological techniques to increase its water production potential. The Water and Sewage State Company of Rio de Janeiro (CEDAE), thought the "Replantando Vidas" socio-environmental project, in partnership with the Maricá municipality are responsible for the largest forest restoration project in this city, planting 32 thousand Atlantic Forest seedlings in 10.4 hectares of river margins and floodplains, impacting directly in the containment of sediments and raising the water infiltration in the soil. To minimize the siltation of rivers and erosion in its margins it is predicted the containment of ravines, slopes and river margins with bamboo. The Ubatiba river present unstable flow rate, varying between 20 to 120 l/s, this large flow variation is typical of poorly managed watersheds, which had lost its water infiltration and storage capacity. The project is of strategic importance to promote water access to the almost 90 thousand inhabitants of the city that depends mainly of this water source. The present situation demands interventions to raise the flow rate and natural water storage in this watershed. These measures lead to a better utilization of the precipitation, reducing the water deficit, especially during the dry season.

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ID 1159

EL NEXO ENTRE CIENCIA, POLITICA Y GOBERNANZA EN EL CASO DE ESCASEZ DE AGUA EN PLANTACIONES FORESTALES EN CHILE

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Esta presentación explorara críticamente el nexo entre ciencia, política y gobernanza en el caso de escasez de agua en plantaciones forestales en Chile. Basándose en literatura reciente sobre ecología política critica que ha enfatizado la naturaleza politizada de la producción y uso del conocimiento científico en la gestión ambiental y su desafío de incluir a la gobernanza en su estudio. El estudio analizara el diseño de un protocolo de plantaciones forestales (2017) en Chile, que por primera vez utilizo la gobernanza en el diseño de una política forestal (protocolo). Este proceso de gobernanza busco la conservación del agua a través del control de plantaciones exóticas, llevado a cabo en respuesta a las preocupaciones sobre la responsabilidad de las plantaciones forestales exóticas para aumentar la escasez de agua. El nexo entre escasez de agua y arboles exóticos es complejo y el debate continúa abierto con explicaciones ambientales sobre su nexo y orígenes atribuidos, que son controvertidos y en ocasiones opuestos entre los actores. A través de una investigación cualitativa y utilizando un enfoque de estudios de casos (Creswell, 2014), la investigación explorara las "ortodoxias ambientales" que son explicaciones consideradas simplistas e inadecuadas en el nexo ciencia-política. Las ortodoxias podrían ser un problema cuando se utilizan en las soluciones políticas a los problemas ambientales. En particular, identificará las

formas en que las ortodoxias fueron utilizadas por las empresas, sociedad civil y el estado de acuerdo a sus intereses y sin considerar las asimetrías de información y poder. Además, explorara el papel que jugó la gobernanza en la validación de ortodoxias y el papel de la red nacional e internacional de socios científicos que asistieron la creación del protocolo de gobernanza. En conclusión, el proyecto considera el potencial de identificar el nexo entre la ciencia, la política y la gobernanza para involucrarse de manera más crítica con la ciencia ambiental.

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ID 1168

ASSESSMENT OF THE HYDROLOGICAL ROLE OF FORESTS IN DIFFERENT CLIMATIC CONDITIONS

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Zonal-provincial features of the earth's surface are reflected on the climate and, respectively, on the river flow. Due to the geographical location, the Central Siberia characterizes by sharply continental climate and the main part of the runoff is created by the precipitation of the cold period of the year. It is established that forest ecosystems, depending on the geophysical background of the territory, can both reduce and increase the flow of rivers. Such ambiguous hydrological significance of forests is due mainly to the specific balance of snow moisture in the forest and in open areas under different climatic conditions. In the conditions of mild winters the forest as compared to non-forest land, “works” as the best evaporator. This is due to two main reasons: a reduction in the unproductive evaporation of snow moisture in open areas (dense and wet snow is not transported by the wind and consequently evaporates less) and an increase in the interception of wet snow by the canopy of highly productive closed stands. In severe winter conditions, the forest on the contrary "works" as a store of snow moisture. This effect is due to the relatively small amount of winter evaporation in the northern open woodlands, compared to the wood-less areas, on which the snowstorms are intensified. Thus, the results confirmed a conception of geographically deterministic hydrological role of forests. They allowed to evaluate the transformation of the hydrological role of boreal forests from forest-steppe to forest-tundra and showed the importance of climatic and landscape-phytocenotic factors that determine the boundary conditions for the transition of forest ecosystems (in comparison with treeless areas) from sources of river runoff to "evaporators" of atmospheric moisture.

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ID 1181

CONSERVACIÓN DE SUELOS Y AGUAS COMO MECANISMO DE ADAPTACIÓN AL CAMBIO CLIMÁTICO E IMPACTOS FORESTALES EN LA CUENCA HIDROGRÁFICA DEL RÍO MAULE CHILE

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Los impactos del cambio climático en la Cuenca Hidrográfica del Rio Maule se expresan en el aumento de la temperatura promedio máxima en +0,6C° en los últimos 14 años, por sobre el promedio mundial (Universidad de Talca, 2017), una reducción de las precipitaciones del orden 30% (periodo 1973-2013, ODEPA 2013) y por ende una merma de caudales al 2025 del 16,3 % (DGA, 2011), como efectos hidro-meteorológicos directos. La sequía y escasez del recursos hídricos afecta la calidad de vida de los pequeños y medianos agricultores/silvicultores. Con alta probabilidad los incendios forestales 2016/ 2017, donde se afectaron del orden de 280.106 ha, constituye la evidencia empírica de un cambio climático antrópico. Se implementan y evalúan medidas adaptativas de conservación de suelos y aguas tales como subsolado con camellón y zanja de infiltración, asociadas a la forestación de plantaciones de Pinus radiata en 17 propiedades. En cada predio se muestrean variables dasometricas y edafo-hidricas. Se realiza 320 parcelas de muestreo para un análisis comparativo de plantaciones con edades similares con y sin tratamientos de obras de conservación de suelos y aguas. Los resultados del estudio indican que la aplicación de medidas adaptativas al cambio climático como obras de conservación de suelos y aguas, inciden en el rendimiento hidrológico forestal a nivel de la microcuenca hidrográfica y se expresan favorablemente en la productividad del sitio forestal. De esta forma, resulta posible compatibilizar un manejo forestal sostenible y un manejo hidrológico forestal en plantaciones forestales en Pinus radiata. No obstante, si las tendencias hidro-meteorológicas continúan, se extenderá la rotación forestal y disminuirán los crecimientos volumétricos, lo que condicionará un manejo forestal sustentable en función de la cuenca hidrográfica. "Los bosques en función de las cuencas".

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ID 1189

DELIMITACIÓN DE ZONAS DE PROTECCIÓN DE CURSOS DE AGUA USANDO HERRAMIENTAS DE MODELACIÓN HIDROLÓGICA

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La vegetación asociada a la zona de protección de cauces cumple un rol clave sobre regulación de la provisión de agua (calidad y cantidad). Reconociendo esta importante función ecológica, la institucionalidad forestal en Chile, a través de leyes y reglamentos, busca proteger esta zona de las acciones de manejo antrópico, como una manera de conservar el recurso hídrico en el largo plazo. Así, se establece que una zona de protección queda definida en función del tamaño del lecho, temporalidad del flujo de agua y pendiente de las laderas que llegan al curso de agua, siendo los estudios técnicos desarrollados por profesionales, como por ejemplo planes de manejo para plantaciones forestales, donde finalmente se determina el grado de protección. Dada las dificultades y elevados costos para la detección de cursos de agua en el campo, y el propósito de generar información en apoyo al manejo y gestión forestal, se testearon los métodos D8 y D-infinity y el programa TauDEM para la modelación de hidrografía superficial en base a modelos digital de elevación de origen radar satelital (SRTM y ALOS), en tres pequeñas cuencas ubicadas entre las regiones del Maule y Los Ríos. Los resultados fueron validados utilizando datos de terreno y luego fueron comparados con información cartográfica existente, identificando diferencias respecto a densidad, largo y presencia de cursos de agua. En cuanto a la identificación de cursos de agua permanentes y temporales se evidencia la necesidad de construir y/o adaptar los algoritmos de modelación considerando las características biogeofísicas y climáticas específicas de las cuencas en los diferentes sectores del país. Este trabajo demuestra la necesidad de contar con datos geográficos de mayor resolución espacial así como una necesidad de validarla en terreno con el fin de cumplir con los requerimientos de normas y protocolos vigentes

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ID 1194

VARIACIÓN DEL BALANCE HÍDRICO DEBIDO A LA SUSTITUCIÓN DE MATORRAL POR CULTIVO FRUTAL EN LADERAS DE CHILE CENTRAL

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En las últimas décadas la Región de Valparaíso ha evidenciado el cambio de uso de suelo en cerros, desde matorral a cultivo de paltos, lo que podría modificar el balance hídrico. Por esto, el presente trabajo busca identificar los cambios en los componentes del balance hídrico debido a esta sustitución de cobertura. El experimento se realizó en la localidad de San Pedro-Quillota, Región de Valparaíso, entre los años 2015 y 2017. Se monitorearon parcelas de escorrentía en una ladera de exposición norte con 30% de inclinación bajo coberturas de matorral y paltos sobre camellones a favor de pendiente. Para cada evento mayor a 6 mm, se determinó la escorrentía, precipitación total con pluviógrafo; precipitación directa con canaletas y precipitación fustal con collarines en los troncos. Con estos valores se estimó la interceptación del dosel y la infiltración al suelo. 2015-2016 fueron años

pluviométricamente secos (<350mm), mientras que 2017 fue año normal. Del total precipitado en años secos (222-240 mm, respectivamente), matorral intercepta entre 31-34%, presenta nula escorrentía y llega al suelo entre 66-69%. Al contrario, paltos intercepta entre 26-40%, escurre entre 1-14% y llega al suelo entre 46-72%. En cambio, para año normal (2017 con 341 mm), matorral intercepta 12%, presenta escorrentía cercana a cero y 88% llega al suelo. En tanto paltos no registró interceptación debido a que fueron rebajados a tocón para superar la sequía. Sólo 1% constituyó escorrentía debido a los abundantes restos de poda que fueron dispuestos en la superficie, produciendo que 99% quedara retenida entre la hojarasca y el suelo. Por lo tanto, la sustitución de cobertura genera cambios en la redistribución de precipitaciones afectando el balance hídrico. Los resultados dependen de la naturaleza de las precipitaciones y de los manejos culturales que se realizan en el cultivo.

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ID 1210

STRONG INFLUENCE OF THE OCEAN IN THE RELIC FOREST ON SEMI-ARID AREA OF NORTHERN CHILE; THE CASE TALINAY, FRAY JORGE NATIONAL PARK

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Semi-Arid North-Central Chile is particularly sensitive to extreme variability in the global hydrological cycle, with severe droughts affecting the area in the last decades so ecosystem within this location are more vulnerable . This is the case of evergreen forest located in Talinay (Fray Jorge National Park), with great (paleo) ecological importance since represents a relict forest segregated for climate change since the Pleistocene. Multi-isotope , hidrogeochemistry and nutrients analysis of coastal fog were made with an integrative perspective to unfold the amount of marine influence in quantitative terms . We developed a simple mix model to identified percentages of fog and rain in the water that is sustaining the forest and identified a seasonal and altitudinal patron. In addition, W-E changes in this amount, with much higher values in the west side of hill and in spring (~90% fog) that decreased until almost 15% at highest altitudes and in winter, where rain is a more important resource than expected. Also, we identified higher nutrients values in fog than in rain, but despite this, our results don't show that this nutrients are been used for the forest. Isotopic and mayor ionic analysis in groundwater demonstrate

that fog is not playing a role in aquifer recharge but is imprinting a signal in ionic values of the groundwate.

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ID 1219

EFFECTS OF EXOTIC FOREST PLANTATIONS ON FUNCTIONAL AND STRUCTURAL INDICATORS OF STREAM HEALTH IN SOUTH-CENTRAL CHILE

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Land-use changes often have significant effects on river flows and sediment yields from specified catchment. Thus, land-use changes have ecological implications not only for the health of terrestrial but also for aquatic ecosystems. Over the last decades, south-central Chile has suffered a drastic replacement of native forest by exotic forest plantations. This is expected to produce a significant decrease of the health of freshwater ecosystems and, consequently, it represents a first order issue that should be considered in water resource management. In this study, we assess the influence of replacement of native forest by exotic plantations on the flow regime and the structure and functioning of river ecosystems. Here, we present preliminary results from eighteen rivers of the Biobío and Araucanía regions of Chile, the area most strongly affected by exotic forest plantations in the country. Study sites were selected based on a control-impact design using a geospatial database of the river network created previously. Eight impacted sites were sampled with total cover of more than 60 % of forest plantations upstream of each of the sampling site. These were paired with ten control sites where native forest cover exceeds 50 % of the catchment. We analysed changes on macroinvertebrate and fish assemblages, physicochemical parameters (pH, conductivity, total dissolved solids, temperature), nutrients, benthic periphyton, granulometry and the effects on ecosystem metabolism based on continuous records (72 h) of dissolved oxygen concentration. Comparison of flow regimes recorded in gauge stations revealed effects of land-use changes on regular floods and low flow events. Furthermore, preliminary results revealed an effect of the land-use change on most of the functional and structural indicators used in this study.

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ID 1220

ENHANCING FOREST PLANTATION MANAGEMENT BASED ON CATCHMENT MONITORING PROGRAM

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Forest plantation have supplied the world's growing demand for wood and its derivatives while reducing the pressure on native forests. Several forestry companies have adapted the management of planted forests in order to meet human needs and contribute to the conservation of natural resources. From the point of view of water resources, forest management must maintain water quality standards and guarantee the supply of water downstream. FIBRIA S.A. conducts monitoring projects in experimental catchments to generate subsidies for water management in catchment scale and to disseminate technical knowledge on the subject. Hydrological monitoring is an important tool to assess the effects of forest management activities on water quality and quantity. Thus, gauge stations were installed in two experimental catchments to continuously measure streamflow. Water samples were collected routinely to determine physical and chemical parameters of water quality. The catchment A has an area of 1,565ha (69% with fast-growing Eucalyptus forests) and has been monitored since January 2005. The catchment B has an area of 127ha (58% with fast-growing Eucalyptus forests) and has been monitored since July 2006. Considering annual average values for the entire monitoring period, water use (evapotranspiration) accounts for 87% and 63% of rainfall, respectively, in catchment A and B. The annual average value of Base Flow Index (BFI) is 50% for catchment A and 43% for catchment B, which means that infiltration and percolation processes are occurring and recharge the groundwater. The average concentration of total suspended solids was 15.7 mg L-1 (n = 513) and 8.8 mg L-1 (n = 418), respectively, in catchment A and B, while the mean annual exports of solids were 42.3 kg ha-1 year -1 and 43. kg ha-1 year -1. Based on results, forest management alternatives are discussed in order to enhance forest management seeking to attend environmental and social demands.

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ID 1221
IMPLEMENTING A HYDROLOGICAL MONITORING PROGRAM AT SUZANO S.A. PULP AND PAPER COMPANY

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ID 1227
RECOVERY TRAJECTORIES OF STREAMS AND RIPARIAN AREAS AFTER FOREST MANAGEMENT

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Streams and their riparian areas are affected by catchment-scale and reach-scale changes from forest practices, and the effects are modulated through the degree of riparian protection afforded. However, we know very little about the recovery trajectories of these ecosystems following forest harvest for different processes and structures.

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ID 1232
PAYMENT FOR ECOSYSTEM SERVICES FOREST – WATER

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Forests and woodlands provide a range of ecosystem services including water quality improvement, flood risk mitigation and in some cases groundwater recharge. Payments for Ecosystem Services (PES) are incentives where direct or indirect payments are made for land use change or management practices to increase or secure the provision of ecosystem services. PESFOR-W is a European COST action (CA 15206) focusing on woodlands for water Payments for Ecosystem Services schemes, promoting novel funding mechanisms for nature-based methods of water protection and restoration. PESFOR-W aims to synthesize knowledge, identify challenges, provide guidance and encourage collaborative research needed to highlight current and potential benefits of forest water-related PES for both water users and the farming community. One challenge identified is the huge geographic differences across Europe, which means that successful implementation requires a sensitivity to local climatic, hydrological and cultural conditions. Measures that work in cool and wet forest countries such as Finland and Sweden may not be appropriate in hotter, drier areas with fewer intact forests. Another challenge which has become apparent during the project is range of institutional structures which exist across Europe. In some countries, national regulations stipulate that forests must be maintained in perpetuity, which means that former agricultural land cannot

subsequently be returned to farming. The importance of such barriers will be highlighted during the COST action so as identify and overcome societal roadblocks to PES uptake. PESFOR-W highlights both the challenges and opportunities associated with afforestation of agricultural land for delivery of water related ecosystem services. The project showcases successful early adopters, as well as identifying the institutional, societal and environmental challenges to wider uptake.

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ID 1236
COMPULSORY AND VOLUNTARY MECHANISMS AND WATER MANAGEMENT IN PLANTATIONS

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Brazil plays an important role in producing pulp, paper, panels, laminate flooring and bioenergy from planted forests, with an important global market-share, particularly in pulp (2nd biggest producer in the world), paper and panels (8th in the global ranking). Besides one of the most restrict land use regulations (compulsory), these industries are strongly committed to voluntary requirements that go beyond legislation, assuring good practices through worldwide recognized certification schemes, as FSC and PEFC. Brazil has 8 million hectares of forest plantation for commercial purposes. From that, 5.4 million hectares are certified. Additionally there are 5.6 million hectares set aside for conservation. Several of mandatory indicators within Brazilian regulations and certification standards, focus on water resources and conservation of natural ecosystems, as a way to assure maintenance of ecosystem services. Within the Brazilian regulatory framework, three policies can be mentioned for safeguarding environmental aspects, especially water resources: The Native Vegetation Protection Law (Forest Code), that addresses land use for production and conservation; the Operational License, which depends on the State and demands risk assessment, mitigation and compensation for the enterprise; and the Atlantic Forest Law, specific concerning the biome where 70% of Brazilians live and a relevant portion of plantations is located. The certification schemes require producers monitor volume and quality of water to ensure operations do not negative impacts on stakeholders and in the downstream of catchment. The thee plantation based industry, in partnership with universities/research institutions monitor 55 catchment, allowing better understanding of water flow and adjustments of management practices. The sector has recently committed to improve monitoring of water management indicators at national level. The initiative will allow better decision making and practices to conserve water resources, besides performance evaluation in the medium-term, improving transparency and

communication with society regarding the relationship between plantations and water.

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ID 1237

ASSESSMENT OF WATER YIELD UNDER GLOBAL CHANGE SCENARIOS IN A MEDITERRANEAN RAINFED WATERSHED DOMINATED BY EXOTIC TREE PLANTATIONS

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In forest plantations, management decisions to increase the productivity and the economic benefit of biomass production can notably affect ecosystem functioning. In particular, water yield which is an ecosystem service that depends on the hydrological processes occurring at the watershed scale. The consequences of the current and future landscape configuration mainly driven by forest plantations, can be especially severe under scarce water availability scenarios due to climate and Land Use and Land Cover Changes (LULCC). The general goal of this research is to assess the impacts of global change on water yield in a Mediterranean rainfed watershed dominated by exotic tree plantations. The study site is the Cauquenes watershed located in South-Central Chile coastal range (36°S) with 800 mm annual rainfall, mean annual streamflow of 5 m3 s-1 and elevations ranging from 150 to 750 m asl. The main land cover classes were identified with a supervised classification using a Landsat OLI scene with an overall accuracy of 86.5%. The corresponding land cover classes were as follows: forest evergreen (43%), shrubland (43%), barren land (10%), native forest (3%) and agriculture (1%). We first calibrated and validated the Soil and Water Assessment Tool (SWAT) based on the results of a sensitivity analysis (Latin Hypercube one-factor-at-a-time) included in the hydroPSO R package. The calibration was done at daily and monthly scale considering years 2009 to 2016. We then analyzed the changes in the streamflows obtained by the SWAT simulations for different land use and climate change scenarios for the years 2015-2035. We proposed two land use scenarios, the first following the most conservative forestry policy guidelines (CUS1), and the second considering a total replacement of non-profitable land use (CUS2). A single climate change scenario (MIROC_ESM) was selected from an ensemble of 26 GCM CMIP5 models (RCP 8.5), downscaled and bias corrected for the region. Satisfactory calibrations were obtained for daily and monthly simulations with a NSE of 0.6 and 0.74 respectively and a PBIAS of -9.8% to -9.5%. Validations produced lower accuracies with 0.41 and 0.65 NSE and -8.5% and 8.5% PBIAS at daily and monthly scale respectively. Future scenarios CUS1 and CUS2 were then assessed only at monthly scale, showing an increment of 9.8% and 42.6% of total forest plantation areas, resulting in an increment of 0.6% and 4.1% of annual streamflows, respectively. The maximum

difference was observed in October, probably due to more intense physiological activity of pines during spring. Climate change reduced in 30% the annual streamflow, and the most affected months were April, November and February with -76.5%, -67.5% and -65.5% of streamflow reduction respectively. The combined effect of LULCC and Climate Change produced a reduction of 30.6% and 33.6% of the annual streamflows. April, November and February were the most affected months with a reduction in streamflows ranging from -65.5 to -78.1%. Streamflow simulations were strongly affected by Climate Change in comparison to LULCC, however a more detailed local parameterization of local vegetation water consumption should be implemented to have an adequate LULCC assessment.

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ID 1245

THE FOREST COVER – WATER YIELD DEBATE: IMPLICATIONS FOR LAND MANAGEMENT IN ETHIOPIA

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"Are forests good for water" remains a hotly contested scientific question. Despite its importance and apparent simplicity, science has difficulty predicting how the water regime reacts to land use change even without considering the effects of climate change. It is therefore not surprising that there can be disparities between national-level water resource management policies and community-level understanding. Even at the local level, upstream/downstream perceptions of land-water management issues and practices can be quite different. The gap between policy and perception is exacerbated by a lack of scientifically based understanding and data-based decision support. This complicates long-term, water-wise decisions regarding the forest management alternatives facing individuals, communities and governments. The issue is particularly apparent in Ethiopia, where one of the world's fastest growing economies is embarking on an ambitious National Forest Sector Development Program that will significantly increase forest cover, with potentially profound implications for water, biodiversity and other ecosystem services. Using the situation in Ethiopia as a starting point, the relation between land cover and water over the past half century has been explored using both traditional methods (runoff records, statistical analysis, and change detection modeling), as well as an exploration of community perception.

Consideration has also been given to the state of the West African Rainforest (WARF), its role in atmospheric moisture transport to the Ethiopia, and the potential impact of its deforestation on the water regime of the Nile Basin. The main findings were that no major, consistent changes in the flow regime despite ongoing land degradation could be detected. Any hydrological changes there were watershed specific. The community perception was also not as simple as deforestation bringing loss (or increase) of dry season flow. Potential explanations of these findings, including data uncertainties, as well as implications for the research agenda in the coming decade are addressed.

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ID 1249

USING REMOTE SENSING TO EXPLORE THE RELATIONSHIP BETWEEN THE SPATIAL CHARACTERISTICS OF CHILEAN MEGADROUGHT AND WILDFIRES

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Droughts have been traditionally monitored and analysed using ground-based data. However, developing countries usually do not have a dense network of meteorological stations to allow a reliable characterization of the spatio-temporal variability of key meteorological variables. In the last decades, remote sensing techniques have become a promising alternative to provide a spatial characterisation of drought-related variables and to quantify drought impacts. In this study we attempt to explore the relationship between the spatial characteristics of the so called "Chilean Megadrought" with the area affected by wildfires between 2015 and 2017 in Central-Southern Chile. Satellite-based precipitation (P) and potential evapotranspiration (PET) estimates are used to characterise the spatial distribution of the Chilean megadrought, while MODIS data are used to identify areas affected by wildfires. The Standardized Precipitation Index (SPI) was used to analyse the impact of precipitation deficits on drought events, while the Standardized Precipitation Evapotranspiration Index (SPEI) was computed to take into account the simultaneous contribution of temperature and precipitation changes on drought characteristics. SPI and SPEI were evaluated at 12-month temporal scale, because they reflect long-term meteorological patterns and should tend towards zero unless a clear trend is undergoing. Drought events are described in terms of its duration, severity, maximum intensity and spatial extent, using the theory of runs with a threshold of -0.84 to identify the onset and duration of drought events. The spatial distribution of drought severity obtained with SPI-12 and SPEI-12 is compared against the area affected by wildfires, to identify preliminary relationships between drought severity and wildfires for the main land cover types present in the study area.

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ID 1253

EVALUACIÓN INTEGRAL DE EFECTOS SOCIO- ECOSISTÉMICOS DEL PAGO POR SERVICIOS AMBIENTALES EN LA CIUDAD DE MÉXICO. DE LOS INDICADORES ACADÉMICOS AL MONITOREO COMUNITARIO

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El Pago por Servicios Ambientales (PSA) es el pago a los dueños del bosque por no modificar el uso de suelo y preservar los Servicios Ecosistémicos. En México el PSA constituye una política pública desde 2003 que no ha sido evaluado con una perspectiva integral (ámbitos social, ambiental y económico). En los bosques del Suelo de Conservación (SC) de la Ciudad de México, el programa cobra gran importancia por la presencia de núcleos agrarios ancestrales con propiedad colectiva de la tierra y las grandes presiones que la urbe significa. Por lo tanto, el objetivo es presentar el desarrollo y la aplicación de una metodología para la evaluación integral de efectos socio-ambientales del PSA con indicadores en San Miguel y Santo Tomás Ajusco (SC Ciudad de México) y su utilidad para el monitoreo comunitario. La generación de la evaluación integral académica parte de proceso previo de generación de indicadores en cuatro etapas: i) diseño, ii) evaluación y ponderación con expertos, iii) selección por viabilidad en México y, iv) aplicación y análisis de resultados. La evaluación integral académica tuvo una metodología mixta, ya que los indicadores son económicos, sociales y ecológicos. Casi en paralelo, se estableció un monitoreo comunitario del agua y recientemente, un monitoreo comunitario de vegetación, fauna, suelo y socio- económico con una serie de capacitaciones y acciones de acompañamiento. Los resultados muestran en la evaluación integral académica efectos positivos del PSA en calidad y cantidad de agua y efectos negativos en lo económico. El monitoreo comunitario documenta la buena calidad y cantidad del agua en el bosque, no en la comunidad. La propuesta de evaluación integral es un esfuerzo por empatar de la manera más inclusiva el trabajo de la academia con los esfuerzos de conservación de la comunidad, a través de procesos de co- aprendizaje considerados exitosos.

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ID 1257

PARAMETERISING COMMON MODELS OF CANOPY CONDUCTANCE AND TRANSPIRATION FOR PINUS AND EUCALYPTUS PLANTATIONS AND THREE IMPORTANT NATIVE FOREST SPECIES (NOTHOFAGUS GLAUCA, N. OBLIQUA AND CRYPTOCARIA ALBA)

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The effect of plantations on water balance in the "Cordillera de Costa" of central Chile is an important resource management issue for the country. The baseline for assessing the impact of land-use change in the region is often Native Forest. Water use by plantations of Eucalyptus and Pinus plantations can be modelled using process-based models of stand scale water balance such as 3PG, CABALA or WAVES. These models use the Penman-Monteith equation to estimate transpiration and therefore require an estimate of canopy conductance. To quantify the effect of substituting plantations for native forest, these models of conductance and transpiration must also be parameterised for native forest species. Using transpiration and climatic variables measured in plantation and native forest plots near the towns of Constitucion (low rainfall), Arauco (medium) and Curanilahue (high) the effect of species on the parameters of a canopy conductance model was quantified in Eucalyptus globulus, E. nitens, Pinus radiata, two deciduous Nothofagus species and the evergreen Cryptocaria alba. Maximum conductance (per unit leaf area) was similar for all species and the response of leaf conductance to radiation and temperature was not significantly different between the species. However, leaf conductance of native forest was more sensitive to increased air saturation deficit and soil drying than Pinus radiata, which was in turn more sensitive to atmospheric and soil water deficit than Eucalyptus. These results can't be extrapolated directly to an estimate of transpiration of different forest types but will be crucial to developing robust models of the effect of land use change in the region.

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ID 1264

A COMPARISON OF CONVOLUTION AND SPATIALLY DISTRIBUTED MODELS TO ESTIMATE MEAN RESIDENCE TIME AT THE HJ ANDREWS EXPERIMENTAL FOREST

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The water residence time provides information about available storage and hydrologic flowpaths. Thus, mean residence time (MRT) can help to quantify long term shifts in flow response driven by disturbances such as forest logging or climate change. We will estimate MRT for three watersheds (WS02, WS08, and Mack) in the H.J. Andrews Experimental Forest located in the Western Cascades using stable water isotopes as tracers and two different approaches: a lumped/convolution model and a spatially distributed/physical model. The comparison of the two approaches will allow us to determine the complexity needed to model MRT in these catchments. MRT will be estimated based on isotopic data collected in 2 different campaigns between October 2000 - February 2003 and between November 2014 - November 2018. MRT estimates based on the first dataset were published in 2005 revealing, for WS02, WS08, and Mack, MRTs of 2.2±0.56, 3.3±1.28, 2.0±0.49 years, respectively. These estimates were found assuming an exponential transfer function, however, the high uncertainties suggest that this simple convolution approach is not characterizing the "plumbing" of the catchments well. In this study we will use the 2000-2003 data and the recent 2014-2018 data in both a spatially distributed model and a revised convolution model, to assess if the complexity provided by the distributed model improves the MRT estimates. We hypothesize that additional parameters will allow us to adjust the model for each catchment and therefore provide more accurate MRTs, and that these estimates will vary based off of catchment topography. Preliminary modeling results using 2000-2003 data show that the MRT estimated from the spatially distributed model for WS08 is close to 2 years contrasting the 3.3 years previously estimated. Additionally, data from 2014-2018 will also be used to estimate MRT to assess if there have been any changes in MRT on the decadal scale.

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ID 1284

PRIORIZANDO ÁREAS PARA RECUPERAR BOSQUES NATIVOS EN EL CENTRO SUR DE CHILE: UN ENFOQUE A PARTIR DE LA PROVISIÓN DE AGUA COMO UN SERVICIO QUE PRESTAN LAS CUENCAS FORESTALES

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En los paisajes forestales de la zona centro sur de Chile es posible encontrar un gran número de captaciones de agua que se vinculan a las necesidades de bebida, saneamiento y otras actividades antrópicas. Muchas de estas captaciones están localizadas en cursos de agua superficiales que son controlados por el régimen de las precipitaciones y las características biofísicas de las cuencas. Para un conjunto de estas captaciones se identificaron y validaron 119 pequeñas cuencas forestales en una parte de la Cordillera de la Costa (35-40° S) definida mundialmente como de alta prioridad para la conservación de bosques nativos. Sobre la base de la cuantificación de una serie de variables biofísicas de las cuencas, así como una aproximación a la relación entre la oferta de agua proveniente de las cuencas y la demanda por parte de la población, se generó un procedimiento para priorizar áreas de restauración de bosques nativos el cual tiene su base en el análisis de componentes principales. Un subconjunto de 12 cuencas fueron utilizadas para realizar propuestas para recuperar bosques nativos utilizando la aproximación conceptual de la Restauración Ecológica. Sobre la base de una revisión bibliográfica, trabajo de campo y talleres con partes interesadas, se definieron los valores de la restauración para los ámbitos ecológicos, sociales y económicos, distinguiéndose elementos determinantes para el éxito de proyectos/programas de restauración los cuales están asociados al control de las amenazas ambientales y sociales, las particularidades territoriales, la disposición a la restauración, entre otros. Finalmente, mediante el criterio de expertos y talleres con usuarios del agua, se definieron algunas propuestas y acciones para cada uno de los valores identificados. Finalmente, se proponen algunos elementos y recomendaciones de política pública que son claves para hacer efectiva la restauración de bosques nativos a gran escala en el centro sur de Chile.

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ID 1298

RELACIÓN DEL MANTILLO Y LA BIOMASA DE RAÍCES CON LA CONDUCTIVIDAD HIDRÁULICA DEL SUELO EN BOSQUES MESÓFILOS SECUNDARIOS Y AGROECOSISTEMAS CAFETALEROS EN VERACRUZ, MÉXICO

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A pesar de que se considera que los bosques mesófilos secundarios (SF) y los cafetales (CA) son una buena alternativa para conservar la alta capacidad de infiltrar agua de los suelos donde existieron bosques mesófilos de montaña (BMM), no está claro qué características de la vegetación modulan la conductividad hidráulica saturada de campo del suelo (Kfs)y si estas persisten en los sistemas derivados. Aquí exploramos cómo los cambios en la vegetación entre SF y CA repercuten en el promedio y la variación espacial del espesor de mantillo y la biomasa de raíces. Y si estas diferencias pueden explicar la Kfs y su distribución en el espacio. Encontramos que el mayor espesor del mantillo, la biomasa total y las raíces gruesas están en el SF del norte. El mantillo está estructurado espacialmente en parches de ca.12 m en escala de parcela en el SF y CA del área sur. Como la Kfs, el espesor del mantillo y las biomasas de raíces gruesas (>2 mm), medianas (1 - 2 mm) y finas (< 1 mm) tienen una distribución espacial en un gradiente norte-sur en escala de paisaje. Nuestro modelo lineal, señala que el área geográfica, uso de suelo y espesor del mantillo, explican la Kfs y su distribución espacial en gradiente. Incluso al incluir la humedad inicial y el porcentaje de arcillas (encontradas como explicativas de la Kfs en un estudio anterior), no fue posible eliminar del modelo área y uso del suelo, dado su alto poder explicativo. Sin embargo, la humedad antecedente fue redundante al incluir el mantillo que tiene mayor poder explicativo. Nuestra modelación sugiere que prevalecen diferencias no estudiadas entre los usos y las áreas geográficas (posiblemente relacionadas con la edafogenésis, historia de uso y prácticas de manejo) que determinan a la Kfs.

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ID 1302

ROL DE LAS BROMELIAS EN LA CAPTURA DE AGUA DE NIEBLA, EL FLUJO DE MATERIA ORGÁNICA Y NUTRIENTES EN UN BOSQUE NUBLADO EN COLOMBIA

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Los bosques nublados (BN) son ecosistemas importantes por sus altas tasas de endemismos y biodiversidad, así como su rol en el ciclo hídrico. Se caracterizan por la abundancia de epífitas (musgos, bromelias, helechos, orquídeas) y por estar frecuentemente cubiertos por niebla, que da origen a la precipitación horizontal (PH). Esta investigación consistió en evaluar la captura de agua de niebla por parte de las bromelias y su rol en la regulación de nutrientes y materia orgánica en un BN de la Cordillera Oriental en Colombia (Guasca, Cundinamarca). Para ello, se realizó un balance hídrico superficial y se monitorearon parámetros fisicoquímicos como pH, carbono orgánico total (COT) y nutrientes en los componentes del balance y en la fitotelmata de las bromelias. Mediante el uso de dos estaciones climáticas dentro y fuera del bosque, se registró la precipitación directa; dentro del BN se realizaron montajes para medir el escurrimiento fustal, el agua que escurre por el tronco, y la cantidad de agua de PH en la fitotelmata de las bromelias. Los resultados preliminares muestran que las bromelias son capaces de retener agua de niebla en su fitotelmata, favoreciendo la PH. Los análisis fisicoquímicos indican que el pH fue ligeramente ácido en todos los componentes del balance hídrico y más ácido en las bromelias; mientras que el COT fue variable, siendo menor la concentración en el agua de lluvia, seguida del agua de niebla, y del agua del escurrimiento fustal. El agua que baja por el tronco, así como el agua de la fitotelmata de las bromelias resultó tener la mayor concentración de COT. Nuestros resultados contribuyen a entender el flujo hídrico y de nutrientes en un BN y posiblemente su exportación hacia cuerpos de agua, así como el rol de las bromelias dentro de estos flujos.

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ID 1304

THE CONTRASTING EFFECTS OF NATIVE FOREST AND FOREST PLANTATION ON CATCHMENT WATER YIELD

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We analyze annual and seasonal water yield for 30 catchments covered by different combinations of native forests and forest plantations in southern Chile (35°-41°S). The water yield is represented by the runoff coefficient (RC), calculated as the ratio between accumulated runoff —streamflow normalized by watershed area—

and accumulated rainfall, at annual and seasonal scales. To characterize forest cover types, we selected catchments with at least 15% of area covered by different combinations of native forests and forest plantations, and calculated a forest plantation index, defined as the ratio of area covered by forest plantations to total forested area (area covered by forest plantation and native forest). This index ranges from 0 (where the tree-covered area of the watershed has only native forest) to 1 (where the tree-covered portion of the watershed consists of exclusively exotic plantations). It should be noted that a given catchment may present other land cover types in addition to forest cover. Our results indicate that annual and seasonal RC decrease with higher relative area of forest plantation compared to the area covered by native forest, especially in spring-summer that corresponds to the dry season. These preliminary results are consistent with lower water yields associated with forest plantations documented for South America, associated to higher evapotranspiration rates and lower soil water storage capacity compared to native forests. Nevertheless, the bi-variate correlations explored here do not explicitly include other factors such as mean elevation of the watershed, precipitation, species and age of plantations. Such multivariate analysis will be implemented to provide a more robust assessment of the impact of forest plantations in water yield.

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ID 1308
AMPHIBIANS AS INDICATORS OF HEALTHY FORESTS

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With nearly 8,000 species described, amphibians commonly inhabit water and humid ecosystems worldwide. Chilean anurans are characterized for their high endemism (72%) and although having a small diversity (63 spp.) when compared with other countries in the region, two-thirds of species are present within the Valdivian Forest Ecoregion. Here we present results from 10 years of amphibian research in South Chile. Most amphibians have a biphasic development from eggs and tadpoles living in water, to post-metamorphic and adults living associated to land, thus playing an important role in the forest trophic web linking aquatic and terrestrial environments. Many of these species are not tolerant to changes in their habitats, making them good indicators of the quality of forest ecosystems. Genus Eupsophus, Alsodes and Batrachyla are comprised by forest frogs typically living associated with native forest and clean water and usually found in undisturbed ecosystems. Insuetophrynus acarpicus is an Endangered frog only known from four streams in the Valdivian forest. Also, while tadpoles of Telmatobufo spp. lives associated with steep rivers and streams for which a sucker-like oral disk has been develop, adults living in the forest have been recorded up to 300 m from the nearest stream. Rhinoderma darwinii lives associated with old-growth forest, commonly

found within wild protected areas. Although this species do not require water bodies for reproduction since tadpoles are brood within the mouth of adult males, the species depend on highly humid substrates for egg development. This species is also very sensitive to the impacts of climate change. The increase in temperature and decrease in precipitations recorded in the Valdivian forest between 1970 and 2000 have reduced R. darwinii habitat in 23 to 40%. Monitoring and further studies of these amphibian species is a convenient model to assess the health of forests ecosystems.

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ID 1311

LANDSCAPE SCALE EROSION AFTER THE HUGE LAS MÁQUINAS WILDFIRE IN THE DECENNIAL CONTEXT

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Forestry planning is one of the main activities for the correct management of forest resources and should reconcile economic and socio-environmental gains seeking equity in water use. The principle of equity or "hydrosolidarity" to be applied requires a) Forest plantations are made in areas with natural availability of water compatible with the activity; b) There is at least legal compliance with the APP and Reserve There are practices of soil conservation; c) concerning riparian areas. It is expected that no catchments (3th order) will have less than 40% Forest cover (native or planted) and not more than 60% (more than 60% being allowed here if it is native vegetation). All catchments with public or private water supply be identified and the harvest plan reviewed. Planting in 4th order basins or more need not follow the above rules. The common situations are 1) The company's area is present in 100% of the watershed and there are no water catchment points, 60 x 40 rule must be apllied;2) catchment has less than 30% of occupation with areas of the company, no action ;3) A catchment is totally occupied by areas of the company and the 60 x 40 rule is not met, plain must be reviewed ;4) Catchment with water supply always must be reviewed. In summary less than 10% of planned harvesting blocks have the potential to be revised. We must highlight 2 facts: company maintains 42% of area for conservation and is installed in an area with natural availability suitable for forestry. The prior inclusion of hydrological criteria (socio-environmental dimension) in planning does not prevent the operational gain

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ID 1349

CAMBIOS HIDROCLIMÁTICOS Y AMBIENTALES EN EL ALTIPLANO SUDAMERICANO, PASADO Y FUTURO

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Durante los últimos 50 años la región de los Andes Centrales ha experimentado significativos cambios ambientales caracterizados por un aumento de temperaturas, un incremento en la elevación de la isoterma 0°C y un continuo retroceso de glaciares. Esto cambios han ocurrido de la mano con un incremento significativo por la demanda de recursos hídricos, los cuales son un factor clave modulando la dinámica de sus ecosistemas asociados y el desarrollo socioeconómico de las regiones circundantes. Mediante la utilización de datos proxy de anillos de árboles, testigos de hielo y de modelación, en este estudio abordamos varias preguntas relacionadas a la dinámica pasada y futura de los recursos hídricos de la región. Se presentarán resultados de investigaciones en curso acerca del monitoreo de los niveles del lago Titicaca y el balance de masa de glaciares bajo una perspectiva multicentenial, predicciones futuras, y de los efectos del clima futuro sobre la distribución de los bosques de esta región semiárida.

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ID 1354

WATER SCARCITY: FISH, FORESTS, PEOPLE, AGRICULTURE – A CASE STUDY FROM SEMI-ARID SOUTHEAST WASHINGTON, UNITED STATES

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Water scarcity is a growing concern in much of the western United States where water supply from forested headwaters is typically "over-allocated": withdrawals of water for municipal and agricultural use leave too little water in streams to support fish, especially in the dry season. Many cities and agricultural areas in the western US depend on water from forested headwaters, which are publically-owned forest managed by the US Forest Service. The Mill Creek basin, an 87 km2 basin in southeast

Washington, exemplifies these conflicts. The City of Walla Walla obtains 80 to 90% of its municipal water from upper Mill Creek, where it has s senior water right dating to 1893. The stream below the City's intake is habitat for endangered fish species, and the current streamflow levels do not meet federal instream flow requirements for fish habitat. This study showed that streamflow from the forested headwaters has declined slightly over the past six decades. If the City stopped water withdrawals during summer months (July through September), and the water remained in the stream, instream flow requirements for endangered fish could be met in the summer. The City would then have to switch to groundwater to meet summer water demand, but the groundwater table has been depleted after decades of withdrawals for irrigated agriculture. In 2010, the City increased water withdrawals from upper Mill Creek during the high-flow period for injection into the groundwater, as part of an aquifer storage and recovery project, but the City has not reduced summer water withdrawals. To meet conflicting objectives among habitat for endangered fish, municipal and agricultural water use, future water sharing arrangements will require a combination of conjunctive use, adjustments of water rights, and conservation.

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ID 1363

CAPTACIÓN HÍDRICA POR ESCURRIMIENTO CORTICAL DE LAS ESPECIES DEL BOSQUE MESÓFILO DE MONTAÑA EN MICHOACÁN, MÉXICO.

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Los bosques de niebla o bosques mesófilos de montaña (BMM) como son conocidos en México, son ecosistemas con alta precipitación y baja evapotranspiración se encuentran severamente amenazados debido al cambio de uso de suelo, por lo que los relictos remanentes tienen alto valor hidrológico y su conservación se considera clave para el abastecimiento de agua. El objetivo del presente estudio fue comparar la captación hídrica por escorrentía cortical de las especies dominantes en un BMM maduro y en un relicto de BMM altamente perturbado. Se realizó un muestreo de la vegetación y se seleccionaron 75 árboles de las 11 especies dominantes (40 individuos de 8 especies en BMM-maduro y 35 individuos de 7 especies en el BMM-perturbado) en cada árbol se instaló en el tronco un anillo colector conectado a un recipiente con tapa. Se realizaron mediciones volumétricas diarias de junio a agosto de 2017. Se registraron 53 eventos de precipitación, con rangos entre 0.71 mm y 73.86 mm con una media de 16.49 mm. La escorrentía cortical correlacionó positivamente con la precipitación bruta en las especies de Pinus leiophylla, Clethra mexicana, Cornus disciflora, Ilex brandegeana y Symplocos citrea . El coeficiente de correlación (r2) va de 0.1155 a

0.8926. La especies con mayor captación de agua por flujo cortical en BMM-maduro fueron: Clethra mexicana, Pinus leiophylla, Ilex brandegeana y Cornus disciflora; y en BMM-perturbado: Stirax argenteus, Arbutus xalapensis, Ternstroemia lineata y Quercus laurina. El índice de escorrentía cortical medio fue de 0,4353 L mm-1 de lluvia mientras que el volumen de almacenamiento promedio es de 8.43 L. La destrucción del BMM en México disminuye drásticamente la biodiversidad y la captación hídrica, es urgente modificar y reforzar las políticas de manejo forestal que promuevan la captación hídrica por encima de la producción de madera para asegurar el suministro de agua.

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ID 1365

THE VALUE OF CITIZEN SCIENCE IN FRESHWATER RESEARCH: AN EXAMPLE FROM AGRICULTURAL SMALL STREAMS IN THE COLOMBIAN ANDES

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Partnerships between people, municipalities, schools, and universities offer a great opportunity to implement citizen-based programs focused on conservation or restoration monitoring of freshwater ecosystems, especially in montane agriculture-dominated areas. An important issue consists in the promotion of native riparian vegetation -from microcatchments to river network systems-, as a habitat for natural enemies and arthropod biodiversity conservation, which could increase their abundance and fitness, being especially useful in highly simplified areas or monocultures such as typical agricultural riverscapes of the Colombian Andes. As part of a monitoring study on traditional and new techniques for evaluating water quality using terrestrial and aquatic insects inhabiting microcatchments under contrasting anthropogenic pressures (agriculture, livestock, gold mining) in central Colombia (Chinchiná river basin), we selected three agriculture-small streams and a reference (forested) stream. The main objective was to propose a socio-environmental framework focusing about the importance of rural people in the knowledge, management and conservation of riverine, riparian and agricultural arthropods; all immersed in heterogeneous landscapes. Our study highlights the necessity of integrating citizen science programs on both freshwater quality, quantity and the surrounding biodiversity of agriculture-dominated streams despite a scarce participation and companion of academia, government and local,

regional and/or national environmental authorities. Conservation strategies involving the establishment of native riparian plants around horticultural systems in montane areas could be an effective way to reduce pest populations mediated by natural enemies growing on this riparian vegetation. Finally, citizen and rural science are changing, and a deeper understanding of arthropod community responses to agriculture intensification in mountainous microcatchments will facilitate their restoration.

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ID 1366

PROGRESS AND CHALLENGES OF LONG-TERM STUDIES ON SMALL WATERSHEDS UNDER FOREST RESTORATION IN THE VALDIVIAN RAINFOREST REGION OF CHILE

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Long term studies of small experimental watersheds in many regions of the world have demonstrated that they are key for the understanding of the effect of changes in forest cover on water yield. Since 2006 we have been monitoring water yield with v-notch gauges and Hobo® data loggers in a set of small watersheds (3,4 – 5,3 ha) in Reserva Costera Valdiviana (RCV), a private protected area owned by The Nature Conservancy (TNC). Annual rainfall in RCV is 2,600 mm, and only 11% falls during the Southen Hemisphere summer (January – March). Temperate Valdivian Rainforest dominated by more than 15 species is the main vegetation type in the Reserve. This study includes three watersheds under restoration in which Eucalyptus globulus exotic industrial plantations were clear-cut in 2010 and started a restoration program through the plantation of native Nothofagus dombeyi and natural regeneration of more than 60 species of native shrubs, trees, herbs, ferns and epiphytes. One watershed was kept as a control watershed maintaining the Eucalypt cover undisturbed. Results indicate an increase in the mean annual runoff coefficients in the restored watersheds from 38% to 55% (7 years of observation) compared to the mean during the pre-treatment period (two years of observation). Nevertheless, precipitation variability has an important effect on water yield recovery, and the summer drought of January through March of 2015 decreased the respective summer runoff coefficient to less than half of its mean value in the pre-treatment period. From the results of water yield as an ecosystem service under recovery we discuss and emphasize the difficulties and challenges that we have faced, in setting and maintaining long-term experiments for the assessment of water yield and regulation in restored watersheds the learned lessons and our proposals for successful long-term studies. These challenges include, maintenance and of v-

notch gauges and instruments working in distant areas, quality control of records, data validation, storage and processing, as well as unplanned changes in vegetation cover due to Eucalyptus reinvasion, long term funding and institutional arrays.

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ID 1369

HYDROLOGICAL IMPACT OF THE GREEN GOLD (AVOCADO CULTURE) IN CENTRAL MEXICO; RAINFALL PARTITION AND WATER USE COMPARISON WITH NATIVE FOREST

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Mexico is the largest producer of avocado (Persea americana) in the world with one third of global fruit production and 180.5 thousand hectares dedicated to this culture, 90% of these are located in the central highlands. In recent years a considerable proportion of this culture had replaced native highland temperate affinity forests. The hydrological impact of the replacement of native forests by avocado plantations is yet to be addressed. We present the first results of the comparison of water consumption between avocado (2 year) saplings and pine native species (Pinus devoniana, P. pseudostrobus) (2.5 year) saplings under field experimental conditions as well as the comparison of rainfall partition between an avocado orchard and a reference native forest site. Sapling water consumption measured gravimetrically to the nearest 5.0 g was normalized by sapling leaf area (m^2). Mean normalized water use of avocado was higher 0.541 to 0.987 $L/m^2/day$ than mean water use of P. psudostrobus (0.190 $L/m^2/day$) and P. devoniana (0.123 $L/m^2/day$). Regarding rainfall partition, net precipitation was 81.75 % and 83.0 % for the orchard and forest respectively, while troughfall, interception, interception loss, and stemflow percentages were 81.6 and 80.6, 18.4 and 19.4, 18.23 and 17.2, 0.17 and 2.4 for avocado orchard and forest respectively. The largest difference occurred in stemflow, native forest stemflow was nearly 14.1 larger times that of the orchard. The low stemflow proportion at the orchard was attributed to low density of trees 156.2 trees ha-1 and tree morphology. Branch pruning created angles near to 90 ° in the lower branches at the orchard preventing intercepted water from flowing into the main stem and dripping off as throughfall. The results suggest that hydrological functioning may be severely affected by land use change from native forest to avocado plantations.

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ID 905

VALOR DE ESTUDIO Y APLICACIÓN DE NORMAS OBLIGATORIAS Y VOLUNTARIAS EN LA PROTECCIÓN DE LOS ECOSISTEMAS "BOSQUE – AGUA" A TRAVÉS UN ENFOQUE INTERDISCIPLINARIO EN EL NORESTE DE LA PCIA. de BS. AS. ARG.

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El objetivo de este trabajo es analizar el manejo del ecosistema "bosque –agua" desde el punto de vista agronómico en la Provincia de Buenos Aires, Argentina, aplicando un enfoque interdisciplinario donde se discutirán las siguientes herramientas, haciendo énfasis en el aspecto social: a) Las Buenas prácticas Forestales (BPF) que permiten al productor rural diferenciar su producto y a su vez implican un gran desafío profesional, y b) La guía de Responsabilidad Social ISO 26.000, los instrumentos internacionales y la normativa jurídica ambiental vigente. La finalidad de las normas mencionadas radica en la protección de los ecosistemas "bosque agua" desde el ámbito socio-ambiental. El ámbito territorial seleccionado abarcará a la Provincia de Buenos Aires debido a que en dicha región se encuentra radicado el equipo de investigación y es donde desarrolla su trabajo de campo. El ámbito temporal se centrará desde el año 2002 (cuando se dictó la primera ley nacional de presupuestos mínimos ambientales en Argentina) hasta la actualidad. Su abordaje se realizará adoptando una estructura de tipo bibliográfico-documental y descriptiva. Se ha recurrido a la estrategia de la triangulación metodológica: la realización de entrevistas a expertos, visitas de campo, y la hermenéutica jurídica de textos normativos y de documentos públicos. Es posible concluir preliminarmente que la protección del ecosistema "bosque – agua" contribuye al bienestar general al brindar los siguientes beneficios: la regulación del clima, la biodiversidad, la protección de las cuencas hídricas, la conservación del suelo, la provisión de agua y el mantenimiento de los ecosistemas. Por eso, su importancia es estratégica a nivel productivo, social, jurídico y ambiental. Asimismo, la utilización de los recursos de estos ecosistemas que hacen las comunidades para su subsistencia, provisión de alimentos, producción agrícola, bienestar social, cultural y espiritual, en general no se conocen o bien son ignorados. En la producción agropecuaria, el impacto del componente forestal como macizos, cortinas forestales y sistemas agroforestales, así como las normas de protección, han sido poco estudiados y resultan de interés dada la complejidad de dichos sistemas y la importancia de los mismos a nivel ambiental, social y económico.

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ID 945
WILDFIRE IMPACTS ON HYDROLOGIC SYSTEMS: THE STATE OF KNOWLEDGE IN HIGH-LATITUDE FORESTS OF NORTH AMERICA.

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High-latitude forests of North-America are characterized by the natural occurrence of large and severe wildfires. For decades, impressive scientific efforts have attempted to improve understanding of the social, economic, and environmental risks these fires induce. Among the plethora of research topics relevant to wildfire science, post-fire hydrology has comparatively received little attention in this part of the world. The present work provides a comprehensive review of post-fire hydrologic studies in Canada and Alaska to identify pressing spatial and theoretical knowledge gaps. We created a database recording more than 80 studies assessing the impacts of wildfires on diverse aspects of watershed hydrologic functioning. Initially, we applied a filter to include only those studies with precise spatial location information. We then classified the studies according to five themes: (a) runoff and change in streamflow regimes, (b) debris flow and channel morphology, (c) erosion and sediment transport, (d) pollutants (nutrients, DOC) and water quality, and (e) aquatic ecosystem response. Finally, we classified the studies by ecoregions to analyze their spatial distribution. Here, we present preliminary results, which we are using to develop future research questions relevant to water and forest governance. This work is in line with other recent initiatives started elsewhere in areas experiencing frequent and severe fire activity. We hope to further integrate this database in a webmapping application and invite the international scientific community to contribute. Such work will help better orient future post-fire research endeavors.

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ID 972
EFFECTS OF FOREST COVER ON SUSPENDED SEDIMENT EXPORT IN CATCHMENTS

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Forests play a key role in rainfall interception reducing the water that falls directly into the surface, increasing soil infiltration, and consequently decreasing the surface runoff and suspended sediments export. At this study we assess the effects of forest cover on catchment suspended sediments export. The objective was assess the hydrological processes of three catchments with different forest cover characteristics: eucalyptus forest plantation with even-age stands management (even-age catchment - EC), native forest (native catchment - NC), and mosaic of forests plantation (different species and ages management - mosaic catchment - MC), all located at southeast region of Brazil. Streamflow, precipitation and turbidity data were collected by pressure transducers, automatic rain gauge and YSI 6136 turbidity sensor, respectively, from November 2016 to October 2017. The suspended sediment yield was estimated through a relation between turbidity data and suspended sediments, obtained by different concentrations of stream bed soil samples collected in each catchment. The sediment export rates ranged from 0.032 Mg ha-1 year-1 to 0.411 Mg ha-1 year-1, far below the limit allowed by FAO (12.5 Mg ha-1 year-1). The results demonstrate small rates of suspended sediments in all catchment, and MC sediment export rates were lower than in the EC. However, we concluded that regardless the management adopted the eucalyptus forests plantation produce low rates of suspended sediments and they are capable to protect the soil. Sediment export dynamics are presented and discussed for these different forests.

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ID 986
CHANGES IN FOUR HYDROLOGICAL PROCESSES UNDER FOREST ALTERATION AND LOSS

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Forests provide a wide variety of goods and services to humanity, including water provision and regulation. Although widely admitted empirically, the scientific evidences of the benefits of forests for water-based ecosystem services (ES) are poorly systematized. Here, we assess the current scientific evidence concerning the importance of forest cover on four processes of the water cycle: evapotranspiration, interception, runoff and infiltration, which are all related to water-based ES. We performed a meta–analysis of experimental studies in order to analyze the effects of land use transitions (i.e. from native forest to other land uses) on these four processes. We compared selected ecosystem performance variables between forested and non–forested land uses using response ratios and random–effects categorical modeling. Results showed that infiltration may be 25-65% lower and runoff 23-75% higher when native forests is converted to other land use types, although evapotranspiration and interception did not consistently change under the land use transitions considered. Infiltration and runoff were not correlated, so

changes in one process cannot predict changes in the other. We presented evidence that, in general, forests can regulate some hydrological processes with potential positive impacts on water balances, but synergies and tradeoffs among these processes under forest cover gains and losses are still uncertain, and difficult to quantify and predict. Attentive considerations are imperative when planning management of forest cover in a landscape or a watershed, due to the still ambiguous impacts on water balance may eventually affect water-based ES supply.

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ID 995

ESTABLECIMIENTO DE ESPECIES FORESTALES INVASORAS EN UN CONTEXTO DE CAMBIO CLIMÁTICO

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Las pináceas representan uno de los mayores problemas de manejo de plantas invasoras en el mundo. En el noroeste de Patagonia, la invasión de pinos se encuentra en una etapa inicial, pero de rápido crecimiento. A su vez, se espera en la región un aumento de las temperaturas y una disminución en las precipitaciones, lo que puede generar cambios en el proceso de invasión de pinos. El objetivo de este trabajo fue examinar como la alteración de variables climáticas (temperatura y precipitación) afecta el establecimiento de Pinus ponderosa, especie considerada como poco invasora en la región, y P. contorta en un contexto de cambio climático. Realizamos un experimento en el noroeste de Patagonia, con semillas y plántulas (3 años) de ambas especies. Se aplicó un diseño factorial completo con cuatro tratamientos: aumento de temperatura, riego, aumento de temperatura y riego, y control. Se observó una menor emergencia de P. ponderosa con respecto a P. contorta, siendo el tratamiento de aumento en la precipitación el que presento menor número de emergencia para ambas especies. Las variables climáticas no afectaron la supervivencia de las plántulas emergidas de ambas especies y P. contorta presentó mayor mortalidad que P. ponderosa. Las plántulas de 2 años de P. contorta fueron afectadas negativamente por la temperatura y presentaron mayor mortalidad en todos los tratamientos en comparación con P. ponderosa. Las proyecciones climáticas para el noroeste de Patagonia promoverían el establecimiento de P. contorta en la región. Este estudio resalta la importancia del cambio climático en el estudio de patrones y mecanismos de invasión de plantas.

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ID 1000

DEMONSTRATING THE CONNECTION BETWEEN FORESTS AND WATER VALUES: A REVIEW

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Forests (conservation and production) provide multiple benefits to society such as timber, carbon sequestration and improved water quality through filtration of nutrients and sediments. Timber products have market values while forests contribution to water quality and water flow regulation do not have a market value and are usually overlooked in decision making. To increase their visibility, methods have been developed to quantify these values using the ecosystem services approach. In this poster, we summarise the review of studies that quantified the values that forests provide to freshwater ecosystems, using a range of methodologies including economic valuation, ecological, spatial approaches. From the review, we found several ecosystem services values provided by forests which include water conservation, water filtration, flow regulation for hydropower, avoided sedimentation and recreational angling. Amongst these services, water conservation through reduction of runoff has the highest economic value, followed by water filtration and recreational angling. Forests can also reduce the volume of water flowing downstream but the cost of this is very small compared to the positive ecosystem services that they provide. We conclude that the water benefits provided by forests far outweigh the cost of the reduction in water yield. Knowing the wider benefits and costs provided by forests on freshwater ecosystems enables a holistic presentation of the full range of ecosystem services provided by forests, including freshwater ecosystem services. This allows forests to be better compared with other land-uses. We provide a New Zealand example where a project was undertaken to assess multiple values provided by a planted forest (including freshwater values) to demonstrate the broader ecosystem service value of forests which aided in the renewal of product certification of a forest company. Governmental agencies in New Zealand are using these indicative values to communicate the multiple values provided by forested ecosystems in policy discussions.

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ID 1008

POLICY INTEGRATION BETWEEN THE WATER AND FOREST SECTORS ACROSS THE EU-27: COMPARISON OF GOVERNANCE MODES AND THE DRIVERS BEHIND INSTRUMENT CHOICES

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The field of research for the current study is forest and water policy in the context of sustainable management of natural resources. The study compares the use of policy instrument choices to integrate the forest and water sectors across the EU Member States. The literature on policy design has observed how sectorial policy-making tends to display a preferred mode of governance: a legal mode of governance contains a preference for the use of laws, a market mode prefers regulation, a corporatist mode opts for plans and organization and a network mode for the use of information tools. The research questions were to understand and compare which modes of governance are prevalent in the national frameworks and which drivers are behind these choices for the case of policy integration between the water and forest sectors. The study followed a two-stage approach: firstly, it mapped policy instruments across EU-27 to integrate the forest and water sectors with the use of a survey tool addressed to authorities and field experts. In the second stage we used Qualitative Comparative Analysis (QCA) to observe the patterns between instrument choice and country contextual characteristics related to water and forests. The study shows that in the EU-27 the legal and network modes are the most prevalent governance strategies to integrate these sectors, whilst the market mode, with emphasis on regulation and financial instruments, is only present in those countries in which the forest and/or the water private industry have an important weight. Despite these main trends, EU Member States do not cluster exclusively within a single mode of governance nor do they display convergence in their chosen policy instruments despite sharing a common policy on water, the EU Water Framework Directive, and the Forest Europe process present on the side of forest policy and management.

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ID 1015

ANALYSIS OF FLOW VARIABILITY ALONG A PLANTATION ROTATION IN AN EXPERIMENTAL CATCHMENT IN SOUTHERN CHILE

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A long-term (1997-2017) investigation into the effects of land-use change on flow variability has been completed at the 0.35-km2 experimental catchment of La Reina (40°20'44"; 73°27'60") in the Coastal mountain range of Southern Chile. After three years of pre-harvesting, the Pinus radiata plantation covering 80% of the total catchment area was clearcut between October 1999 and March 2000. A new plantation (P. radiata and Eucalyptus spp.) was established in winter (June-July) 2000. Data were analyzed for the different hydrological years (1st April-31st March) starting in 1997-98 and finishing in 2016-17. Annual runoff coefficients and the frequency of flow pulses (defined as an occurrence of a rise above given flow thresholds and based on hourly discharge measurements) were used to investigate the flow variability through the entire period. Mean annual runoff coefficient was 0.36 for the pre-harvesting years (1997-98, 1998-99 and 1999-2000), increasing to a mean of 0.72 for the period 2000-2004, then reducing to mean values of 0.68 for the period 2006-2009 and 0.47 for the rest of the study. The number of pulses above 10M (where M is the median value of discharge for the entire period) follows in general the same trend. The mean number of pulses for the three pre-harvesting years (1997-2000) is 36, increasing to 79 for 2000-07 and reaching 20 pulses in the final phase of the study. During the hydrological year 2016-2017, i.e. 16 years after clearcutting, the annual runoff coefficient and the number of pulses have not reached pre-harvesting values. La Reina, to date the longest-running forest research catchment in Chile, has now been closed down. Even at a world scale, though, its data series is unusually long and provides an important benchmark against which to compare results from elsewhere.

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ID 1023

EXPLORING THE PRIORITY AREA OF FOREST RESTORATION PROJECTS IN LUGU LAKE, CHINA

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Analyzing the movement of an ecosystem centroid has proven to be a powerful tool for assessing and monitoring its spatial variation. In this study, with GIS, we applied the centroid theory to analyze the temporal and spatial distribution of the ecosystem centroid in Lugu Lake, and its surrounding areas. We explored how the centroids changed from 1990 to 2015 (their positions, movement directions, and movement distances), for finding the priority area of forest restoration projects. The results showed each type ecosystem had a relatively independent and stable centroid in the region. This was caused by the effective conservation efforts of local governments and organizations and, particularly, the effective policies and measures that have been implemented in recent years. Compared with forest, grassland, and wetland ecosystems, built-up land and cropland ecosystems changed more profoundly. As for the extent and direction of centroid changes, the

centroids of forest, grassland, and wetland ecosystems moved continuously back and forth in a relatively small area, indicating that these ecosystems were in a relatively dynamic equilibrium. Furthermore, increased human-induced disturbances, especially, tourism developments, can be a trigger for ecosystem centroids to move towards Lugu Lake. It is dangerous for this natural reserve because those disturbance patches will affect the water quality and the landscape value. The new ecological restoration projects need to increase the wetland ecosystem services, and young forest management should be managed according to local conditions, with an emphasis on forest cultivation to improve forest quality.

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ID 1035

A MULTI-INSTRUMENTED WATERSHED TO ESTIMATE THE WATER BALANCE AT THE MANTIQUEIRA MOUNTAINS IN EXTREMA, MG/BRASIL

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The Mantiqueira mountains are the headwaters that supplly the largest part of the water for industry, agriculture, human and hydroelectric use in a highly economically and densely populated region near Sao Paulo, SP, Brazil. The area upstream the Cantareira water reservoir system was long colonized since 1700, although we did not find scientific studies that describe the surface water regime at the various specific processes from the atmosphere to soil, aquifer and rivers. We set up a multi-instrumental experiment to measure climate, the surface-atmospheric fluxes, soil moisture, water table depth and runoff at the Posses river, Extrema, MG (area ~1200 ha) in an watershed managed by the Conservador das Águas Program that restored springs locally with native forest vegetation since 2009. The question rises with the lack of information on the role of the soil, groundwater, topography and surface cover, respectively, in controlling the water regime from the hillslope to small-medium watershed scales. We selected three sub-basins (individual areas < 50 ha) to deploy the instrumentation, that included DeltaT-Pr2 (soil moisture 1 m depth), water table depth (Solinst), weather variables (precipitation, temperature, humidity and wind speed) (Vaisalla WXT), the sensible heat flux, evapotranspiration and CO2 flux (eddy covariance system LiCor IRGASON), and streamflow measured at a total of 8 stream gauge (Solinst) that include the mouth and middle course of Posses river. Measurements started in Oct 2014 with the complet set of measurements established as of Jan 2018. Preliminary results showed at the Posses river the mean annual rainfall of 1485 mm and runoff of 575 mm, with 247 mm/yr as baseflow, or streamflow as 39% of rainfall and groundwater contribution as 43% of total discharge. This work was designed and has been developed with the Project Climate-Smart Watershed Investments in the Montane Tropics of South America, financed by FAPESP/Belmont Forum and supervised at IAG/University of São Paulo.

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ID 1044

REGULATIONS OF CLOUDINESS ON CARBON, WATER AND ENERGY EXCHANGES BETWEEN A RIPARIAN POPLAR PLANTATION AND ATMOSPHERE

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Increased concentration of airborne particulate matter and aerosols in many countries of the Northern Hemisphere has led to decreased total and proportion of direct radiation reaching the ground, air temperature (Ta) and vapor pressure deficit (VPD), thus affecting the carbon, water and energy exchanges between the terrestrial ecosystems and atmosphere. However, the biophysical regulatory mechanisms of cloudiness on such processes are still unclear, particularly for riparian ecosystems. We used eddy covariance technique and micrometeorological sensors to measure the mass fluxes and environmental factors of a poplar plantation adjacent to the Chaobai River in Beijing, China during the growing seasons (April to October) from 2014 to 2017 for investigating how ecosystem gross primary productivity (GPP), evapotranspiration (ET) and energy partitioning responded to the changes in cloudiness. Our results indicated that light use efficiency (LUE) of the plantation increased with increasing clouds and GPP peaked when the clearness index (CI) was between 0.45 and 0.65, at which diffuse photosynthetically active radiation (PARdif) had reached its maximum. On the contrary, cloudiness suppressed ET and evaporative fraction (EF) primarily due to the stomatal closure caused by the decrease in direct radiation (Rdir). In addition, the ratio of stomatal sensitivity (m) and reference conductance (Gsref) under cloudy skies (0.48 mol m-2 s-1 ln(kPa)-1) was significantly higher compared to that under clear skies (0.36 mol m-2 s-1 ln(kPa)-1) ($p < 0.05$), which indicated that the riparian poplar plantation with anisohydric behavior weakened stomatal control on water loss under clear skies for avoiding leaf burn arising from higher sunlight and temperature. These findings highlight the importance of clouds as a vital factor in regulating plantation productivity and water use strategy, and provide implications for increasing adaptive capacity of forests to climate change.

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ID 1046

FIELD EVIDENCE FOR IMPACT OF FOREST COVER AND FOREST MANAGEMENT PRACTICE ON FLOOD PEAKS

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Despite global concern, the extent to which forests mitigate floods remains controversial, giving rise to public misperception and poorly conceived policy. In the UK, there have been calls for large-scale afforestation following two decades of damaging floods but the rationale behind such programmes may be misplaced. In Chile, forest companies have a keen interest in the hydrological impacts of forests, the better to achieve environmental certification for their products. The emerging evidence is that forests may reduce flood peaks resulting from small to moderate rain storms but not from extreme storms. However, existing field evidence is ambiguous. It has also been argued that a measure of forest impact based on flood magnitude is flawed and that a sounder basis is flood frequency. These uncertainties are explored using data from contrasting field programmes: a paired forest and grassland catchment experiment (scale 1.5 km2) in northern England and a single catchment subject to forest growth and logging cycles in southern Chile (scale 0.35 km2) . Land use is found to affect the peak runoff response for a given rain event for moderate floods but the effect is reduced if the different catchment states are already comparably saturated; the different responses also converge at extreme floods. Flood frequency curves show significant differences according to land use at the smaller return periods but the data are not sufficient to confirm that the pattern extends to the highest floods. Forest cover tends to reduce peaks compared with absence of forest cover at the Chilean site but increases peaks at the UK site because of the influence of drainage ditches. Forest management practice is therefore shown to have a significant effect on flood response while forest cover on its own does not appear to mitigate the largest flood peaks.

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ID 1054

RUNOFF DYNAMIC AND NUTRIENT TRANSPORT UNDER EXTREME RAINFALL EVENTS IN TEMPERATE FORESTS - RESULTS FROM LARGE-SCALE SPRINKLING EXPERIMENTS

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Phosphorus (P) is an essential element for primary productivity of an ecosystem. Natural forests are known to be limited in P supply and therefore develop tight P-recycling strategies. The P availability is, however, significantly affected by P-losses by hydrological fluxes in the surface and subsurface during rainfall events. Since typical observations of runoff and nutrient losses sample baseflow conditions and average rainfall-runoff events, possible tipping points for extreme events are not known for forest ecosystems. However, climate change may increase the probability of such extreme events and the loss of essential nutrients like phosphorous may disproportionally increase. We present the results of several large-scale (200 m2) sprinkling experiment on three highly instrumented forested (fagus sylvatica) experimental hillslopes in Germany, where we simulated extreme rainfall events with moderate intensities (12 - 15 mm/h) but for a duration of 10-12 hours. The sprinkling water was labeled with deuterium and the water was deionized to simulate nutrient poor rainfall. Using zero-tension lysimeter at different depths and a 10m wide hillslope trench, we could quantify the lateral and vertical fluxes and transit times and the associated transport of nutrients (i.e. Phosphorus) for recharge and the lateral subsurface flow. Using novel in-situ sensors for P and water isotopes, we could also study the dynamics of water and nutrient uptake by the beech trees during and after such extreme rainfall event. We could observe the typical P-flashing at the beginning of the sprinkling event, the immobilization of P in the upper organic rich horizon and the high lateral and vertical losses at the system boundary. Despite the extreme event, dilution of P was limited to a certain threshold, indicating very rapid recovery of the ecosystem with respect to P production. The transit times of water uptake to the trees was, however, surprisingly large with several weeks. By quantifying not only the lateral but also the vertical water and nutrient losses from the plots we could close the water and P-mass balance for three contrasting forest ecosystems.

ID 1092

THE INFLUENCE OF FORESTS ON THE RUNOFF FROM SMALL TO MEDIUM CATCHMENTS

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The climate change is broadly considered to have an impact on the temporal distribution of precipitation in the region of Central Europe. It is expected that this will result in more frequent occurrence of extreme events such as floods and droughts. Forests are considered as a very important for the runoff from small to medium catchments as they can help to mitigate the impact of the climate change. Another measure, which is considered as very important in the Czech Republic, is building of small water reservoirs, which should help the retention of water in the landscape. This is in the focus of the research project NAZV KUS QJ1620395 "Restoration and building of ponds in forest areas as a part of sustainable

water resources management in CZ". One of the project tasks is the investigation of influence of forests on the hydrologic regime. The main question is, how the presence of forests influences the runoff conditions. In this contribution, the influence is investigated using the assessment of the relationship between the percentages of forests and selected characteristics of runoff in 28 catchments up to 150 km2 in the Czech Republic. As runoff characteristics, mainly the runoff coefficients and the shape of the recession limbs of selected significant rainfall-runoff events were identified through the analysis of discharge time series. The results of such analysis indicate the influence of forests on the runoff regime which is however affected by the influence of other factors. The results will be helpful in the planning of new small water reservoirs to be built in forest areas, which can support the management of water.

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ID 1097

MODELOS AGROFORESTALES PARA LA DIVERSIFICACIÓN DE LAS OPCIONES PRODUCTIVAS DE PEQUEÑOS PROPIETARIOS DEL SECANO DE LA REGIÓN DE COQUIMBO

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El Instituto Forestal ha desarrollado con éxito diversos programas y proyectos asociados a tecnologías que permiten aprovechar al máximo la escorrentía superficial de las aguas lluvia, concentrando su disponibilidad en diferentes tipos de obras de conservación de suelo con el propósito de mejorar su infiltración, evitar la erosión y aumentar la productividad en algunos sectores con especies forrajeras y madereras. Transcurridos 20 años de validación, la presente propuesta desarrolla un escalamiento tecnológico que avanza en la incorporación de opciones productivas de mayor valor, utilizando especies propias de cultivos agronómicos de secano, en estas obras de conservación de suelo diseñadas con el objetivo de cosechar aguas lluvia. En función de ello, el proyecto plantea "Desarrollar modelos agroforestales que permitan diversificar las opciones productivas de pequeños propietarios del secano de la región de Coquimbo, a través del aprovechamiento de la escorrentía superficial, obras de conservación de suelo y el rescate de especies valiosas multipropósito". Para lograr el propósito del proyecto se establecerá la siguiente estrategia: Diseñar y establecer Modelos Agroforestales con diferentes especies arbóreas forestales y frutales multipropósito de bajo requerimiento hídrico en obras de conservación de suelo en 5 comunidades agrícolas del Secano de la región de Coquimbo. Evaluar el efecto de las variables edafoclimáticas en la supervivencia, tasa de crecimiento y desarrollo de los diferentes Modelos Agroforestales y su relación con la disponibilidad del contenido

hídrico y manejo de la escorrentía. Diseñar e implementar una ETT orientadas comunidades agrícolas y profesionales públicos y privados del sector silvoagropecuario de las zona árida y semiárida de chile, para la promoción de los modelos diseñados.

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ID 1100

EXPLORING THE EFFECTS OF THE "GRAIN FOR GREEN" PROGRAM ON THEDIFFERENCES IN SOIL WATER IN THE SEMI-ARID LOESS PLATEAU OF CHINA

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Land-use/vegetation is an essential variable on controlling the heterogeneities and distribution patternof soil water content (SWC). Along with large-scale re-vegetation in arid and semi-arid areas, the varia-tions of SWC ascribed to the land-use conversion have been considered as an important factor to assessthe re-vegetation efforts. In this study, soil water data at the depth of 0–300 cm were obtained by field observation in two eco-hydrologic zones in Loess Plateau of China. The mean annual precipitation was 350–400 mm (zone-A) and 500–550 mm (zone-B), respectively. The differences in SWC were analyzed among different land-use types; and the SWC in different restoration years was also discussed using the method of space replacing time. Results indicated that (1) the differences in SWC between the two zones were lower in re-vegetated lands (2.76%, forestland and 4.22%, for shrub land) than in abandoned farm-land (5.85%). The differences in re-vegetated lands diminished gradually as the soil depth (0–300 cm)increased, whereas the abandoned farmland represented an opposite trend. (2) Although the variation trends of SWC in abandoned farmland of the two zones were different as the restoration years increased,the differences in SWC between abandoned farmland and native grassland both diminished gradually.This meant the soil water deficit relative to native grassland would be alleviated as the progress of abandoned farmland. (3) As the restoration years increased, the differences in SWC between re-vegetated lands and native grassland increased gradually because of the continuous decrease of SWC in re-vegetated lands. The consequence will be that the soil water deficit in the re-vegetation lands is aggravated continually. From the perspective of soil water restoration and conservation in semi-arid areas, the abandoned farmland should be a more reasonable method than re-vegetated lands covered with introduced plants.

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ID 1104

Respuestas de macroinvertebrados al establecimiento de una mini central hidroeléctrica

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La necesidad mundial creciente de energía, el agotamiento de combustibles fósiles junto a la toma de conciencia de disminuir las emisiones de CO2 propician el desarrollo de fuentes de energía renovables no convencionales (ERNC) para generación de electricidad, aunque sus ventajas y desventajas no están del todo claras. En la búsqueda de combatir el cambio climático un objetivo del Gobierno de Chile y del Ministerio de Energía es desarrollar una matriz energética baja en carbono, renovable y sustentable propiciando la masiva entrada de energías renovables, siendo meta al 2050 que un 70% a 90% de la generación eléctrica provenga de esa fuente. Esta situación hace necesario evaluar los efectos de la instalación de pequeñas hidroeléctricas sobre los ecosistemas lóticos. El estudio que realizamos buscó determinar la calidad ambiental del río Chanleufu (Parque Nacional Puyehue) posterior a la instalación y operación (mayo de 2016) de una mini central hidroeléctrica de pasada, mediante la aplicación de índices bióticos basados en diversidad de macroinvertebrados bentónicos y considerando variables fisicoquímicas del agua. El Chanleufu se origina de la confluencia de esteros de altura en el cordón montañoso entre los volcanes Casablanca y Puyehue y en su cuenca predomina el bosque nativo adulto denso y semi denso. Contábamos con una línea de base previa, realizada en 2014, y monitoreamos el río en primavera de 2017 e invierno de 2018. Al comparar la diversidad de macroinvertebrados registrados antes y después del establecimiento de la central, se aprecian cambios en la estructura de las comunidades de macroinvertebrados, pasando a predominar aguas abajo los taxa capaces de tolerar cambios de turbiedad, pese a que no se observan modificaciones en las demás variables fisicoquímicas. Los resultados arrojados por esta investigación pueden ser claves para la toma de decisiones frente al desarrollo e instalación de nuevos proyectos de mini centrales.

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ID 1129

PLANIFICACIÓN TERRITORIAL PARA UNA GESTIÓN INTEGRADA DE RECURSOS HÍDRICOS: CASO DE ESTUDIO ZONAS DE MONTAÑA DEL RÍO CLARO DE RENGO, REGIÓN DE O'HIGGINS

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Los recursos naturales e hídricos se encuentran en un momento crucial, debido a que la sobreexplotación y el cambio climático han aumentado la vulnerabilidad de los territorios que dependen de los recursos de montaña. Actualmente se deben cambiar los paradigmas y formas de utilizar los ecosistemas. En este contexto, la presente investigación plantea lineamientos a considerar para las políticas públicas de un territorio de montaña, incorporando criterios ambientales, hidrológicos y sociales, tomando como modelo de estudio la cuenca del río Claro de Rengo, Chile central. En este estudio se propone que una Junta de Cuenca debería ser la organización que aglutine todas las instituciones u organizaciones involucradas en la gestión del agua. Se propone que por medio de las legislaciones vigentes y herramientas municipales se planifique territorios de montaña, todo financiado por los usuarios de los recursos hídricos mediante un sistema de pago. El siguiente modelo de gestión pretende sentar las bases que puedan ser replicadas en otros territorios para implementar proyectos y así proteger los recursos hídricos para generaciones actuales y futuras.

ID 1148

ASSESSING THE VULNERABILITY OF THE SECOND LONGEST-LIVED TREE SPECIES TO A DRIER CLIMATE

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Fitzroya cupressoides is an endemic and endangered conifer, and the oldest tree species in the Southern Hemisphere. Despite Fitzroya forests growing in relatively wet environments, some populations face very dry conditions during summer. This study aims to evaluate the vulnerability of Fitzroya to water scarcity in southern Chile at the scale of individual trees (adults and saplings). This as a basis for the design of conservation strategies to safeguard the persistence of these forests in a drier future. We focused our study in two sites: The northern Coastal Range (AC) and the Central Depression (FN). We assessed water potentials (WP) throughout the growing season 2015-2016, as well as leaf and stem hydraulic traits and strategies to understand Fitzroya's susceptibility to water scarcity. Minimum water potentials during summer (WPmin) were not that negative in Fitzroya (-1.3 to-1.5 MPa), even considering that the studied season was the second driest on record. This could probably be due to a high leaf capacitance in this species. The relatively large stem safety margins (SSM) found for Fitzroya in this study (adults AC: 3.65, saplings AC: 1.2, adults FN: 2.23, saplings FN: 2.52 MPa); seem to be an important hydraulic safety valve in this species. Therefore, within the continuum of species strategies to cope with water stress, Fitzroya has features pertaining to both ends of the continuum: tissues with large safety margins, and tissues that maintain milder operation pressures through reliance on capacitance. Although Fitzroya appears to be relatively resistant to water scarcity, saplings from the Coastal Range, seem to be the most vulnerable to

the aridification trend in southern Chile. This places a warning about the future of Fitzroya forests in this area. Long-term on site studies at different scales (trees, forest stands, watersheds) are necessary to design and adapt conservation strategies.

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ID 1156

ANÁLISIS COMPARADO DE LA LEGISLACIÓN INTERNACIONAL DE SISTEMAS BUFFER "ZONAS DE MANEJO DE CAUCE CON ÉNFASIS EN AMÉRICA LATINA Y CHILE .

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Las zonas amortiguación vegetacionales (buffer) resultan fundamentales para la protección contra la erosión, la sedimentación, contaminación y eutroficación de los cauces y cuerpos de agua en función de factores edáficos, vegetacionales, hidrológicos, topográficos, climáticos y paisajísticos. La zona de manejo de cauces (ZMC) debe establecerse o mantenerse en los márgenes de cursos de agua permanentes y no permanentes, debe tener el ancho suficiente para confinar los sedimentos visibles dentro de ZMC. Se presentan diversos esquemas de protección vegetacional para cursos hídricos según legislación : 1- Sistemas Buffer, EE.UU. Forest Service Se establecen recomendaciones técnicas que varían desde 16,5m. a 50m. y se incrementa 1,5m. en función de cada 1% de pendiente, para anchos medios que varían de 25m. a 50m. 2- Matas Ciliares Brasil (1965) En el Código Forestal de Brasil establece fajas de protección vegetacional de cursos hídricos que aumentan con el ancho y que varían de 30m a 500m de cada margen de ríos, lagos, embalses, represas o nacientes, respecto del espejo de agua. 3- Fajas Hidroreguladoras, Cuba (1988) En la legislación forestal de Cuba, se establece el concepto de "Fajas Hidroreguladoras" para la protección de ríos y embalses. En relación al orden de los ríos varían de 10m. a 20m. 4- Legislación comparada en Chile en relación a fajas de protección vegetacional cursos hídricos y cuerpos de agua 4.1- Ley de Bosques 1931 4.2- Ley de Bosque Nativo 2007 4.3- Protocolo de plantaciones forestales Se establecen anchos mínimos como zonas de protección en función de la pendiente. Los anchos de protección varían de 5 a 30 m. Se incluyen medidas de protección en humedales, manantiales, cuerpos de agua y microcuencas abastecedoras de agua potable. El presente trabajo abordará su factibilidad técnica y normativa legal para mejorar y garantizar los servicios eco sistémicos a nivel de cuencas hidrográficas.

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ID 1174

ANALYSIS OF HYDROLOGICAL AND STRUCTURAL INDICATORS ON FOREST RESTORATION

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The relation forest cover is fundamental in the correct functioning of the hydrological cycle and this subject is currently debated on a global scale due to the growth of the degradation of natural areas. The scenario of environmental degradation must be reversed, and the recovery of degraded areas is only efficient if we seek the inclusion of abiotic factors in their goals and object of study. Thus, this research sought to characterize the behavior of hydrological indicators and forest structure in environments under restoration by different methodologies. Soil cover per litter, incident light, soil penetration resistivity, soil water infiltration speed, soil surface moisture and soil density were evaluated in nine plots of 10 × 10 meters distributed equally in areas of abandoned pasture, area in an eight-year-old restoration and native forest fragment from March 2016 to June 2017. In each plot the height and diameter of all arboreal individuals with DBH ≥ 5 cm were measured. For each treatment values of diversity, equability and basal area were calculated. In the abandoned pasture, higher soil density, penetration resistivity, surface moisture and incident luminosity were obtained. In the native forest fragment were observed greater diversity, basal area, proportion of non-pioneer and zoocoric species, water infiltration rate in the soil and litter cover. The area under restoration was similar to the pasture for infiltration, humidity and density, and to the forest fragment for litter cover, luminosity, resistance to penetration and infiltration. Better values were observed for soil parameters in more diverse environments with a more consolidated structure. In the area under restoration at the age of eight, improvement in soil parameters was verified before the complete recovery of the forest structure, showing the important function of this environment in the relation forest-water.

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ID 1195
FOREST ECOSYSTEM SERVICES OF WESTERN HIMALAYAN WATERSHEDS, INDIA

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The monsoon in Western Himalayan region plays key role in watershed functioning and forests provide substantial services in regulation of hydrological processes of watersheds. In the present study, the forest ecosystem at Arnigad improves the hydrological functioning of watersheds by: delaying lag time (5 minutes), reduced

stormflow ~82%, enhanced baseflow ~52%, soil moisture, SM (13% and 31%) at 50 cm and 80 cm depth and steady infiltration rate (SIR) by 22% over Bansigad. These enhanced values indicated potential for soil water storage at forested watershed (Arnigad) and helps to understand the amount and rate of water that is available during a dry season. Reduction in long term mass wastage (denudation rate), suspended sediment and bed load by 41%, 18% and 75% at Arnigad confirms the crucial role of trees and forests in maintaining balances in ecological functioning, biological diversity, landslides etc. The results consequently helps in regulation of ecosystem services in Himalayan region and will act as a valuable reference for watershed mangers and planners for water resource management.

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ID 1203

FORREST GUMP AND REFLECTIONS ON A FORESTED COASTAL LANDSCAPE IN ALABAMA

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In the iconic film "Forrest Gump," the main character Forrest Gump grew up in the fictional town of Greenbow, Alabama. Greenbow was supposedly situated in the southern coastal region of Alabama near the actual town of Bayou La Batre, Alabama. The idyllic forested coastal landscape surrounding Forrest Gump's childhood home serves as a prime example of a forested coastal landscape in popular art and culture. In addition to the colorful array of characters and circumstances during Forrest Gump's childhood, one can also see that the intrinsically appealing attributes of the forested coastal landscapes surrounding Forrest Gump's childhood home also played a pivotal role not only in how the character Forrest Gump grew up but also in the broader meaning of the film. This idyllic forested coastal landscape helped establish in the film a sense of place and purpose for Forrest Gump. Based on the extraordinary popularity and cultural impact of this film, it is worth highlighting the key attributes of the forested coastal landscape that helped make Forrest Gump's childhood home so appealing and why this particular landscape was such an important component of the film. A reflection on the landscape as portrayed in the film may also be relevant for managers, scientists, policy makers and others when measuring and evaluating differing values and competing interests along forested coastal landscapes throughout the southeast United States as well as other parts of the world.

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ID 1214

IMPACT OF MINING ON THE FLORISTIC ASSOCIATION OF GOLD MINED SITES IN SOUTHWEST NIGERIA

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Biodiversity loss is reaching an alarming level globally, this is due to several occurrences in land use, human activities and climate change. And all these factors have both direct and indirect influences on the environmental conditions. Due to the abundance of mineral resources in Nigeria, mining activities are common. One of these is gold; predominantly by Artisanal and Small-Scale Mining (ASM) in the Southwest region of Nigeria. Though the benefits of mining are known, its influences on the floristic composition of the Nigeria rainforest ecosystem is of great concern. In order to understand the floristic composition, extent of biodiversity loss, identification of functional plants and characterized plant species surviving on the mined sites (despite disturbances from the mining activities and its level of contamination); this study compared the floristic composition of an abandoned mining site (Site 1), an active mining site (Site 2) and an undisturbed vegetation sites (Control) in the Southwest region of Nigeria. The results show that the floristic composition of all the sites has been altered. However, the level of disturbance on the mined sites (i.e. both Site 1 and 2) was higher as a result of exposure of the forest soils to direct sunlight, pollution, and other involved mining related stresses. Several of the native species were being replaced by invasive species. Some of the species are known as functional species and they stand as ecological indicators. Nevertheless, there are forest remnants still existing on the mined Sites. This, therefore, suggest the need for appropriate conservation and management.

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ID 1239

EVALUACIÓN DE LA PROVISIÓN DE SERVICIO ECOSISTÉMICO DE PROVISIÓN DE AGUA BAJO ESCENARIOS DE RESTAURACIÓN DE BOSQUE NATIVO PARA LA ADAPTACIÓN AL CAMBIO CLIMÁTICOS Y SU EFECTO EN LA PRODUCCIÓN FORESTAL

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La industria forestal en Chile ha generado paisajes dominados por especies exóticas altamente demandantes en agua, afectando la provisión del servicio ecosistémico de agua y la resiliencia de los ecosistemas y comunidades. Nuestra investigación, desarrolla un modelo de producción de madera y provisión de agua en una cuenca de tres mil hectáreas en el centro de Chile en el largo plazo. Tomando un caso real, se determinaron las coberturas de vegetación y la provisión de agua potencial para cada una de éstas. Para las plantaciones además se determinó la producción de madera y de agua de acuerdo a la edad de éstas, desde su plantación a la cosecha (18 y 25 años). Con estos datos se modelo un en un escenario "business as usual", con condiciones de cobertura de vegetación estables en el largo plazo. Escenario que es contrastado con otros escenarios de la cuenca en que se restaura secciones de vegetación en zonas de amortiguación de distintos anchos (10-60 metros) alrededor de cauces hídricos. Resultados preliminares muestran que en el largo plazo el promedio anual de provisión de agua aumenta un 9% y 22% al restaurar una zona de amortiguación de 10 y 30 metros respectivamente. Mientras que la producción de madera se reduce en 10% y 27% respectivamente. A la vez, se explora el efecto de la restauración de las zonas de amortiguación ante escenarios de disminución de las precipitaciones y su efecto como una herramienta de adaptación al cambio climático. A partir de esta investigación, hemos avanzado en comprender y modelar los trade-offs entre bienes y servicios ecosistémicos y la importancia de los paisajes multifuncionales como una herramienta de adaptación al cambio climático.

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ID 1255

BIODIVERSIDAD DE FLORA Y FAUNA ASOCIADA A LOS CUERPOS DE AGUA SUPERFICIALES, SU CALIDAD Y SU CANTIDAD EN SUELO DE CONSERVACIÓN DE LA CIUDAD DE MÉXICO, MÉXICO

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El Suelo de Conservación (SC) de la ciudad de México, México es la superficie designada para la conservación y el usufructo de los pueblos originarios dueños del territorio. Ocupa 149, 000 hectáreas de gran riqueza biológica (11% de la nacional y 2% de la mundial), pero también histórica y cultural (nueve pueblos originarios de origen prehispánico). En el SC se han implementado políticas públicas ambientales federales y locales evaluadas, tanto por el gobierno como la academia. Es el caso de San Miguel y Santo Tomás Ajusco (suroeste del SC), se evaluaron los efectos del Pago por Servicios Ambientales (PSA) con indicadores económicos, sociales y ecológicos. El objetivo del trabajo fue mostrar los resultados de los indicadores ecológicos y determinar las relaciones espaciales entre hidrología y biodiversidad.

Los indicadores correlacionados fueron cantidad y calidad del agua, salud forestal y calidad del bosque como hábitat, calculados por medio de metodologías mixtas entre la documentación oficial (informes, estadísticas y cartografía disponible), los estudios publicados y el monitoreo comunitario. Cada indicador se calculó en dos periodos previo al PSA (antes del 2000) como línea base y después del PSA (2000-2017). Los resultados muestran cambios mínimos en términos de calidad y cantidad del agua, aunque en los años recientes han desaparecido algunos flujos superficiales. La biodiversidad de vegetación se ha alterado en algunos sitios, donde hay mayor actividad humana y pequeñas variantes en la calidad del agua, además de la reducción de ciertas especies vinculadas a la disponibilidad del agua. En términos de biodiversidad de fauna, son pocas las especies cuya población se recupera y es estable y/o se distribuyen ampliamente, mientras otras especies se mantienen cercanas a los cuerpos de agua disponibles y otras especies disminuyen en términos de población y distribución a razón de los cambios forestales más que hídricos.

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ID 1270
CUANTIFICACIÓN DE ERRORES ASOCIADOS AL DISEÑO DE UN INVENTARIO LIDAR EN UNA PLANTACIÓN DE PINUS RADIATA EN CHILE

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La aplicación del LiDAR en inventarios forestales ha supuesto la generación de productos cartográficos de mayor precisión y con mayor precisión en la representación real de la totalidad de la extensión del área de estudio. En el presente trabajo se estudiaron y cuantificaron distintas fuentes de error en inventarios forestales con LiDAR. Este estudio ha mostrado que los desplazamientos en la localización del centro de la parcela entre 5 y 15 m suponen el aumento del error absoluto medio en un 6%. En cuanto a la densidad de pulsos del vuelo LiDAR, una reducción de estos de 17 a 1 puntos/m2 ha supuesto un aumento del error de escasa importancia, en torno al 0.2% de media del error cuadrático medio. A partir de un total de 50 parcelas muestreadas se realizó una reducción del número de parcelas de forma sucesiva, llevando a cabo procesos de Machine Learning, donde se ha cuantificado la influencia del tamaño de la muestra en la bondad de los modelos. Esta reducción sucesiva mostró que el error cuadrático medio de los modelos se mantiene constante hasta un set de 20, en torno al 30% para el volumen (V), 26% para la densidad (N) y el área basimétrica (G) y 4% para la altura

dominante (H0). Por último, una reducción en la medición de sólo 6 alturas en cada parcela, ajustando y aplicando posteriormente una ecuación generalizada altura-diámetro para toda la zona de estudio, afectó a la predicción del volumen y el área basimétrica, en un 64.3% y un 12.1% del error cuadrático medio, respectivamente.

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ID 1274

ESTUDIO DE LA TIPIFICACIÓN DEL MIOMBO EN LA PROVINCIA DE HUAMBO (ANGOLA) A TRAVÉS DEL USO DE IMÁGENES DE MEDIA Y ALTA RESOLUCIÓN

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El Miombo es uno de los ecosistemas de mayor importancia de África Subsahariana, cubriendo unos 270 millones de hectáreas. Este tipo de ecosistemas está formado por mosaicos de bosques secos y sabanas boscosas, caracterizados por una gran diversidad florística y de fauna. El aprovechamiento antrópico se centra en la extracción de leñas y producción de carbón para energía doméstica, pastos, alimentos y plantas medicinales. El conocimiento relacionado con la estructura, composición y dinámica del Miombo es muy limitado. Dada la amplia superficie que cubren estos ecosistemas y las limitaciones técnicas y de investigación que pueden encontrarse en los países donde se distribuye, la teledetección se presenta como una herramienta fundamental para avanzar en este proceso. El objetivo de este trabajo fue desarrollar una metodología de tipificación del bosque de Miombo basada en el análisis de imágenes de media y alta resolución y elaborar una cartografía temática de dicha tipificación del Miombo en la provincia de Huambo (Angola). A partir del procesado de las imágenes y del análisis de la información procedente del inventario forestal realizado, se calcularon diferentes índices de biodiversidad y se caracterizaron las unidades de muestreo. Esta información ayudó a determinar, a través de técnicas estadísticas, los distintos grupos de vegetación. Finalmente, empleando el método de clasificación supervisada a través del algoritmo de la mínima distancia se obtuvieron cuatro tipos de vegetación de Miombo para la provincia de Huambo (Angola), caracterizados en función de las especies, estado de degradación, índices de biodiversidad, composición y estructura.

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ID 1289

SUMMER STREAMFLOW DEFICITS FROM REGENERATING DOUGLAS-FIR FOREST IN THE PACIFIC NORTHWEST, USA

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Despite controversy about effects of plantation forestry on streamflow, streamflow response to forest plantations over multiple decades is not well understood. Analysis of 60-year records of daily streamflow from eight paired-basin experiments in the Pacific Northwest of the United States (Oregon) revealed that the conversion of old-growth forest to Douglas-fir plantations had a major effect on summer streamflow. Average daily streamflow in summer (July through September) in basins with 34- to 43-year-old plantations of Douglas-fir was 50% lower than streamflow from reference basins with 150- to 500-year-old forests dominated by Douglas-fir, western hemlock, and other conifers. Study plantations are comparable in terms of age class, treatments, and growth rates to managed forests in the region. Young Douglas-fir trees, which have higher sapwood area, higher sapflow per unit of sapwood area, higher concentration of leaf area in the upper canopy, and less ability to limit transpiration, appear to have higher rates of evapotranspiration than old trees of conifer species, especially during dry summers. Reduced summer streamflow in headwater basins with forest plantations may limit aquatic habitat and exacerbate stream warming, and it may also alter water yield and timing in much larger basins. Legacies of past forest management or extensive natural disturbances may be confounded with effects of climate change on streamflow in large river basins. Continued research is needed using long-term paired-basin studies and process studies to determine the effects of forest management on streamflow deficits in a variety of forest types and forest management systems.

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ID 1303

WATER BALANCE OF CATCHMENTS COVERED WITH PINUS RADIATA AND NATIVE FOREST BEFORE AND AFTER THE FIRES OF JAN 2017

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Since 2015, Arauco has monitored streamflow in 14 catchments covered with plantations and native forest. The objective is to compare the effect of plantations on water balance with that of native forest. Components of the water balance were measured at the catchment and stand scale. Five of the experimental catchments

are in the Quivolgo management area, just north of Constitucion in the Maule region. This is a low rainfall area for commercial plantations. One of the Quivolgo catchments was covered by native forest while a second was 47% native forest with the balance covered by a 23-year-old Pinus radiata plantation. Measurements of water balance commenced in May of 2016 and continued until late afternoon on the 25th of January 2017 when all of the Quivolgo catchments were burned in a large wildfire. After the fire, all of the plots and the streamflow measurement weirs were re-instrumented. This paper quantifies the streamflow and evapotranspiration in two catchments from 9 months before the fire to 12 months after the fire. Flow in the months immediately after the fires was compared with flow during the same months in the year before the fire. Flow in February of 2017 was only 10% of the flow in February 2016 for both catchments. This persisted during March in the Pinus catchment, but flow recovered to be nearly half the pre-fire value in the native forest catchment. In the year before the fire the runoff rainfall coefficient was approximately 15% greater in the native forest than in catchments with Pinus. After the fire the runoff—rainfall coefficient was similar in both catchments. This suggests a re-setting of the hydrology in both catchments post-fire. Monitoring will continue for the next several years to compare the water balance and growth of different forest types at the same age post fire.

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ID 1306

ÁRBOLES VIEJOS, RETOÑOS Y SEMILLAS: LAS VOCES DE LOS CAMPESINOS DEL BOSQUE NUBLADO

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Los bosques nublados (BN) son de los ecosistemas más amenazados pese a su alta diversidad biológica y a su importancia en la provisión de servicios ecosistémicos (SE), como por ejemplo el suministro de agua dulce. Un estudio socio-cultural de las relaciones que se tejen entre los diferentes miembros de las comunidades rurales y el BN, permite entender la importancia de la existencia del BN para la supervivencia de estas comunidades, así como la importancia de la existencia y la preservación de costumbres locales para asegurar la permanencia de estos bosques; se entiende entonces como una relación de co-existencia y ¿por qué no?, de beneficio mutuo en el marco de los socio-ecosistemas. Así, lo polifónico en esta investigación cobra valor; escuchar las voces de los campesinos: hombres y mujeres adultos, jóvenes y niños, en torno a su convivir con el BN permite co-construir conocimiento a partir de los diferentes saberes y experiencias vividas en el territorio. Este trabajo hace parte de la valoración socio-cultural de SE en el BN. El estudio se abordó con una comunidad rural en Cundinamarca (Colombia) que depende mayoritariamente de los SE del BN para su subsistencia. A partir de entrevistas semi-estructuradas a los adultos y actividades lúdicas para los jóvenes y

niños, se obtuvo información sobre la historia del BN en ese territorio, los SE de provisión (agua, alimento, medicinas y materiales), así como la identificación de relaciones afectivas con plantas y animales, además de algunos relatos de seres sobrenaturales asociados con el bosque. Mediante narrativa e ilustración gráfica se resumen los resultados de las historias y sentimientos de la comunidad rural en relación al BN, la nostalgia y añoranzas del bosque en el pasado, los saberes heredados y construidos inter-generacionalmente, y la esperanza de que la vida continúe en este socio-ecosistema.

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ID 1347

EVALUACIÓN DE LA RESPUESTA HIDROLÓGICA BAJO DISTINTOS ESCENARIOS DE COBERTURA DE SUELO EN LA CUENCA DEL RÍO LUMACO, CHILE

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El objetivo es evaluar cómo las aplicaciones de políticas forestales afectan el uso del suelo y la respuesta hidrológica en cuencas de régimen pluvial como la del Río Lumaco, Araucanía, en el Centro-Sur de Chile. Se utiliza una combinación de un modelo de cambio de uso del suelo (Conversión Dinámica del Uso del Suelo y sus Efectos, Dyna-CLUE) y un modelo hidrológico semi distribuido de base física (Herramienta de Evaluación de Suelo y Agua, SWAT) para comparar la respuesta hidrológica bajo los usos de suelo históricos entre 1990 y 2015 contra un escenario que considera una mayor protección del bosque nativo basado en la implementación de la Ley de Bosque Nativo cuya discusión se inició en el congreso en 1993 y se aprobó en 2008 . En el escenario de conservación no se permitiría la sustitución, esto es que no se remplace bosque nativo por plantación de monocultivos forestales, o la deforestación, además de considerar variables tales como la distancia a caminos, distancia a asentamientos urbanos, distancia a los cursos de agua, altitud y pendiente, que pueden influir en el cambio de uso del suelo. A su vez se calibra el modelo hidrológico, utilizando el paquete de R HydroPSO que utiliza el Algoritmo de Optimización por Enjambre de Partícula (PSO). Los Resultados de la calibración arrojaron un coeficiente de eficiencia Nash-Sutcliffe de 0.89, con un coeficiente de determinación (R2) de 0.94. Mediante una regresión logística se encontró que para los seis usos de suelo analizados; agricultura, bosque nativo, matorrales, plantaciones forestales, áreas sin vegetación y cuerpos de agua, la pendiente es significativa. La combinación de

modelamiento ambiental con políticas permite evaluar el efecto de estas en el medio ambiente.

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ID 1364

HYDROBIOLOGY AND BIOGEOCHEMISTRY IN HEADWATER STREAMS OF SOUTHERN CHILE: EFFECT OF FOREST MANAGEMENT

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Headwater streams represent more than 80% of total watersheds in many montane areas elsewhere and play important roles in regulating nutrient, organic matter, benthic organisms and sediment fluxes throughout the drainage network. However, forest management in or close to riparian vegetation have influenced the hydrobiology and biogeochemistry of these mountain ecosystems for centuries. The main of this research was to examine terrestrial and stream ecosystem linkages in hydrology, macroinvertebrates, carbon and nitrogen biogeochemistry in contrasting evergreen- or deciduous-dominated watershed of southern Chile (42°S). We report on findings from the San Pablo de Tregua Experimental Forest during continuous experimental trials over mid-2007 to January 2009 to highlight the usefulness of hydrobiology and biogeochemistry data to a wide-diversity of ecosystem scientists. Using the traditional paired-catchment approach, we evaluated changes or the effect of forest thinning activities on water quantity, litterfall input, macroinvertebrate composition, structure and function, leaf decomposition (mass loss and benthic invertebrate influence), and C/N fluxes among trophic levels by SIA. Our main findings were: 1) increase annual runoff in both evergreen and deciduous microcatchments. 2) no significant differences in the litterfall pattern between streams and evidencing the typical autumnal pattern. 3) thinning activities promoted higher leaf mass losses, associated to highest k-values and the composition and density of shredders and collectors. 4) functional resulting changes into each sets of streams were associated with higher richness, density and biomass values from both leaf bag colonizers and in-stream invertebrates. 5) changes in C and N fluxes depended on invertebrate composition, FFG and season. Finally, harvesting inevitably changes imports and exports of carbon and nutrients, but we need to understand yet how forestry activities affect ecosystems functioning; however thinning activities can constitute a key tool to manage headwater Andean streams, from both structurally and functionally.

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ID 1666

IMAGE CLASSIFICATION TO IMPROVE THE ESTIMATION OF GHG EMISSIONS THROUGH MAPPING OF ARCHETYPICAL VEGETATION IN THE SAVANNAHS OF BRAZIL

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Since the pre-industrial era, the principal contributors to greenhouse gas (GHG) emissions have been human society and its activities. During the last decades, emissions from tropical deforestation to the global carbon pool have increased, as large areas of savannah and wetland have been replaced by pasture and agricultural land at unprecedented rates. Since ecosystem productivity estimation depends on knowledge about the location and extent of its different components, it is fundamental to correctly represent the spatial distribution of vegetation types to estimate accurate GHG emissions associated with deforestation from these areas. In this context, the objective of the present work was to map the archetypal ecosystems of the Brazilian Cerrado (a savannah region) using Landsat images, aiming to reduce the uncertainty of land cover change emissions modeling. To do this, we first use a mask of human-influenced areas and water bodies. Then, masked 30 meter-resolution Landsat images from the Cerrado's savannahs were used to generate Linear Models of Spectral Mixture. Spectral thresholds are thus defined for three archetypes of vegetation (woodlands, shrublands and grasslands) and used to classify for classification through image-slicing. In addition, the map adequately included areas not originally observed due to the presence of clouds and their shadows. The resulting classified-images were vectorized, smoothed and visually inspected. Results show the distribution of the areas covered with natural vegetation divided into the three main types of vegetation and their relation with the total area of the biome. The data will be used to detail the Cerrado's phytophysiognomies, to associate spatially explicit information of biomass density and thus provide more accurate GHG estimations related with deforestation.

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POSTER

POSTER ABSTRACT INDEX

N°	Theme	Author name	Title
1	T1	Clara María Minaverry	LA NORMATIVA (SOBRE POLÍTICAS PÚBLICAS) ORIENTADA HACIA EL CUMPLIMIENTO DE LOS OBJETIVOS DE DESARROLLO SOSTENIBLE A 2030 EN LA PROTECCIÓN DE LOS BOSQUES Y DEL AGUA EN ARGENTINA Y URUGUAY
2	T1	Irena Creed	Rescaling the Forest-Water Discourse to Meet UN Global Goals
3	T1	Nathalia Granato Loures	The Brazilian Tree Industry and the SDGs most linked to water resources
4	T10	Julia Jones	Unexpected resilience of large-scale river infrastructure and water management systems to climate change
5	T11	Don White	Water use and water use efficiency of Eucalyptus and Pinus plantations modelled using CABALA, 3PG and WAVES
6	T11	James Rodríguez Echeverry	Impact of land-use change on Valdivian Temperate Forest and its ecosystem services: basis for planning decision-making
7	T11	Jami Nettles	Simple upscaling to bracket estimates of water yield change due to forest management
8	T11	Juan A. Blanco	Fertilization by carbon dioxide plays a minor role in long-term growth patterns of Scots pine in mixedwoods at the Pyrenees
9	T11	Juan José Quiroga	Modelos de Caudal estival en base a variables ecohidrológicas asociadas a Bosque Nativo, plantaciones de Pinus radiata y Eucaliptus globulus en cuencas distribuidas entre el Bio-Bio y la Araucanía.
10	T11	Marlene Huerta Sandoval	Snowfall interception in a deciduous Nothofagus forest and implications for spatial snowpack distribution.
11	T11	Marlene Huerta Sandoval	Using shifting species distribution models to inform rainfall runoff models
12	T11	Mauricio Galleguillos	Assessing spatio-temporal impacts of global change on water and biomass production processes at catchment scale: a synergistic approach based on remote sensing and coupled hydrological models to impro
13	T11	Pilar Mena	Caracterización de los parámetros morfométricos de cuencas andinas relacionados a crecidas
14	T11	Xavier Maza	Metodología para el uso de redes neuronales artificiales en la predicción de variables hidrológicas: Una revisión
15	T11	Matheus Ogasawara	Calibration and validation of Budyko framework to watersheds in southeastern Brazil. presenter:
16	T2	Andres Iroume	Moderate increases in runoff after forest harvesting: the contrasting effects of tree cutting and long term drought
17	T2	Carol Cerda-Peña	Intra-specific and inter-specific variations of leaf wax fatty acid from three plants in riparian ecosystem from temperate forest
18	T2	Cong Wang	Natural restoration might be more suitable in China's Loess Plateau-a case study for two typeical restoratoin species

19	T2	Elizabeth Ramirez	Evaluation of the differences between the components of the water balance between scrub and plantations of Pinus radiata
20	T2	Guillermo Andrés Barrientos Alarcón	Effect of intensive management forestry on headwater catchments, application of the TETIS® model
21	T2	Guillermo Palacios	Cartografía de daños por 'Candidatus Phytoplasma pini' sobre masas de Pinus halepensis Mill. a partir de información del sensor MSI-Sentinel 2A
22	T2	Guillermo Palacios	Comparativa de los errores obtenidos en un inventario LiDAR por variables de masa y de árbol individual en un plantación de Pinus radiata en Chile
23	T2	Ji Qi	Modelling the Effect of Changing Precipitation Inputs on Deep Soil Water Utilization
24	T2	Nataly Miranda	Movimiento de Agua a lo largo de una Ladera de Bosque Nativo en la Cordillera de la Costa de la Región del Maule
25	T2	Rebecca Almeida	Hydrological functions associated to litter deposition in Atlantic forest under secondary succession
26	T2	Shankar Adhikari	Ecosystem Service in Adaptation to Climate Change in Panchase Mountain Ecological Regions of Nepal
27	T2	Shyue-Cherng Liaw	Application of Trend Analysis to Explore Hydrological Variations under Climate Change in the Taimali Stream Basin, Taiwan
28	T2	Steven Brantley	Interspecific Variation in Hydraulic Redistribution and its Importance to Plant Communities
29	T2	Xing Wu	Long-term enhanced nitrous oxide emission and reduced methane uptake after clear cutting from a temperate spruce forest soil
30	T3	Kelly Tonello	Analysis of changes in the Brazilian Forest Code in Permanent Preservation Areas of Top Hills, Mountains and Mountains Ranges
31	T3	Kevin Bishop	Forestry and elevated levels of mercury in aquatic ecosystems: What to do when best management practices are not good enough?
32	T3	O. Stribling Stuber	Fire exclusion increases canopy interception loss in longleaf pine (Pinus palustris) forests
33	T4	Carla Chiles	Variable Source Area (VSA) delineation and validation in sub-tropical forested catchments in Brazil
34	T4	Carlos Oyarzún	Las plantaciones forestales y sus efectos sobre la calidad del agua en el centro-sur de Chile: una revisión
35	T4	Giulia Baldaconi da Silva Bispo	Water-related ecosystem services in landscapes with several coverage conditions of forested-savanna
36	T4	Maria Poca	Woodland's degradation and its effect on soil profile water dynamics in highlands of central Argentina
37	T5	Guillermo Andrés Barrientos Alarcón	CHARACTERIZATION AND ABUNDANCE OF DIATOMS IN FOREST WATERSHEDS TO EVALUATE THE EFFECT OF FOREST MANAGEMENT
38	T5	María Jesús Suazo Silva	A preliminary study of the ecosystem health of Lake Pullinque and threats of surrounding area
39	T7	Kelly Tonello	HYDRO-ENVIRONMENTAL DIAGNOSIS OF THE CONSERVATION OF THE SPRINGS, ITANGUÁ CATCHMENT, BRAZIL

40	T7	Kelly Tonello	THE PROTECTION OF SPRINGS IN CONSOLIDATED URBAN AREAS: CASE STUDY IN BRAZIL
41	T9	Alan Abreu	Riparian forest restoration in Macacu river with prisoners workforce
42	T9	Carla Josef	Measurements of surface water flow in restored springs at the Mantiqueira mountains in Extrema, MG/Brasil
43	T9	José Omar Carter R.	Restauración, protección y conservación de la micro cuenca productora de agua de la comuna de Corral, región de Los Ríos Chile
44	T9	Kelly Tonello	INDICATORS OF FOREST RESTORATION: A CONTRIBUTION FROM THE SOIL STRUCTURE
45	T9	Kelly Tonello	Medium and Large-Size Mammals in Regeneration Area in Savana, Brazil
46	T9	Xiomara Gálvez	PROPUESTA DE UN ÍNDICE DE VULNERABILIDAD SOCIAL ANTE PÉRDIDA DE SERVICIO ECOSISTÉMICO PROVISIÓN DE AGUA: CASO DE ESTUDIO PARA UN SECTOR RURAL UBICADO EN LAGO RANCO, REGIÓN DE LOS RIOS, CHILE
47	T3	Ricardo Taniwaki	Blue Targeting Tool: a simple forestry planning for riparian buffer zones adapted to Brazilian streams
48	T4	Carolina Bozetti Rodrigues	Eucalyptus forest plantation management: effects on water quality and export of nutrients and suspended solids
49	T2	Maria Francisca Clemo	Strong influence of the ocean in the relic forest on semi-arid area of northen Chile; the case of Talinay, Fray Jorge National Park
50	T2	Maura Díaz	Caracterización de una plantación forestal de especies nativas de la Universidad Nacional de Asunción, Paraguay
51	T2	Maura Díaz	CARACTERIZACION FLORISTICA EN EL BOSQUE DE GALERÍA DE LA UNIVERSIDAD NACIONAL DE ASUNCIÓN
52	T7	Giovany Guevara	The value of citizen science in freshwater research: An example from agricultural small streams in the Colombian Andes
53	T9	Nicole Burger	Experiencia piloto para la priorización y generación de propuestas de restauración de bosque nativo en cuencas proveedoras de agua en Lago Ranco, Región de los Ríos.

336

LA NORMATIVA (SOBRE POLÍTICAS PÚBLICAS) ORIENTADA HACIA EL CUMPLIMIENTO DE LOS OBJETIVOS DE DESARROLLO SOSTENIBLE A 2030 EN LA PROTECCIÓN DE LOS BOSQUES Y DEL AGUA EN ARGENTINA Y URUGUAY

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En el presente trabajo nos proponemos relevar y categorizar a la normativa que regula las políticas públicas orientadas hacia la protección jurídica conjunta de los bosques y del agua en Argentina y en Uruguay. Se delinearán los lineamientos que sean indicativos del cumplimiento de los correspondientes Objetivos de Desarrollo Sostenible (ODS) a 2030, para luego medir su nivel de desarrollo a través de la aplicación de una serie de paradigmas vinculados con la administración y/o la gestión ambiental (Colby, Penna y Cristeche entre otros). El ámbito territorial seleccionado abarca a todas las jurisdicciones argentinas y a Uruguay, que goza de un sistema unitario de gobierno. Su abordaje se realizará adoptando una estructura de tipo bibliográfico-documental y descriptiva. Se ha recurrido a la estrategia de la triangulación metodológica: la realización de entrevistas a expertos e informantes clave; el análisis de documentos públicos y la hermenéutica jurídica de textos normativos y de documentos públicos. Es posible concluir preliminarmente que en la normativa vinculada con las políticas públicas analizadas, en algunos casos se han detectado las tres áreas incorporadas por el principio de sostenibilidad (social, ambiental y económico). Cabe destacar que este principio ya fue ampliamente superado, y que en la normativa se han podido relevar también otros paradigmas de administración y/o gestión ambiental, entre otros, el de la gestión integrada de los recursos hídricos que presentan objetivos similares a los planteados por los ODS. Asimismo la limitación vinculada con el acceso a la información pública al momento de requerirse para realizar el análisis del éxito o del fracaso de las políticas públicas, disminuye notablemente la efectividad del presente estudio en la práctica, ya que en la mayoría de los casos se cuenta únicamente con fuentes periodísticas que informan sobre aspectos generales (de difusión), y que no desarrollan los aspectos técnicos.

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1144
Rescaling the Forest-Water Discourse to Meet UN Global Goals

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Governments across the globe have agreed on an ambitious agenda referred to as the UN 2030 Global Goals. Water is central to the 17 Global Goals and global prosperity as a whole. The Global Forest Expert Panel (GFEP) on Forest and Water provided an independent expert evaluation of the scientific knowledge about the interactions between forests and water intended to inform relevant international policy processes on the Global Goals. The GFEP on Forest & Water came to the following conclusions. First, forest-water resources need to be recognized. We need to recognize that forest-water resources are key to achieving the 17 Global Goals. Second, forest-water relations need to be reconsidered. We need to reconsider how we manage forests locally to adapt to climatic variability and climate change – by managing for leaf area index, effective soil cover, soil infiltration rate, and rooting depth. But we also need to reconsider how we manage forests globally – by managing for the complete hydrologic cycle perspective including upstream-downstream and upwind-downwind hydrologic connections. Third, forest-water interventions need to be reimagined. We need to reposition the forest-water discourse, which has tended to be conducted at local scale, and to open up a global conversation about forest-water interactions. This will present new challenges for policy makers, who will need to design governance systems to optimize forest water resource management from local to global scales (and vice versa) and incentive-based mechanisms to coordinate interests and concerns. The UN 2030 Global Goals offer new possibilities to open up a global dialogue about forest-water interactions.

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1235
The Brazilian Tree Industry and the SDGs most linked to water resources

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Brazil is South America's most influential country, rising economic power and one of the world's biggest democracies, but also a country that has significant influence in

sustainable development agenda, due to the amount and diversity of resources and how their management affects regional and international levels. The Brazilian Tree Industry, an association that represents more than 60 member companies and regional associations, has put significant efforts into showing and measuring the commitments of the forest plantations based industry to the Sustainable Development Goals - some of those have a direct or indirect reflect on quality and availability of water. The SDGs this industry is most directly linked to include: a) SDG 4, by providing environmental education for local communities located in the operation´s surrounding areas; b) SDG 6, by developing and deploying technologies that reduce the water use in the mills, making it available for other uses; c) SDG 8, by generating and diversifying income and jobs through outgrowers programs, resulting not only in rural development and social inclusion but also information sharing and best practices that help conserving water resources in small-farms; d) SDG 13, removing carbon from the atmosphere and providing renewable, recyclable and certified products, stocking carbon during their life-cycles; e) SDG 15, by setting aside 42% of total area for conservation purpose of natural ecosystems, which helps maintain and improve biodiversity and other resources such as water and soil; and f) SDG 17, establishing partnerships and cooperation initiatives with academy, research institutions and NGOs for better management, monitoring, transparency and commitments in regional and national level. This presentation aims to show case-studies and projects that forest-plantations based companies apply in their operations and strategies related to rational use and conservation of water. Additionally, presenting what is the pipeline in water management and the relationship with forestry.

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1290

Unexpected resilience of large-scale river infrastructure and water management systems to climate change

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Climate change is altering streamflow, potentially limiting water availability for people and ecosystems. Attempts to understand how climate change affects water supply have simulated future climate effects on reservoir operations. However, no studies have used historical data to examine past responses of water management systems to ongoing climate change. We develop a conceptual model of the water management system and use observational databases to quantify how climate change in otherwise relatively pristine headwaters has influenced water yield and timing downstream of reservoirs over the period 1950 to 2012 in the large, international, and highly managed Columbia River Basin. We find that while summer

reservoir inputs have declined since 1950, consistent with anthropogenic climate change, historical reservoir operations have adjusted to mitigate these trends downstream, although there has been no overarching directive or deliberate attempt to use dams for climate change adaptation. This apparent compensation appears to be an emergent property arising from many agents, each responding independently to different stimuli, within the river management system. By buffering downstream water users from emerging water shortages, this behavior may lead to complacency. However, finite reservoir size combined with continued declining inflows raises the possibility of future failures of reservoir management to meet objectives. These future failures of reservoir management may cascade across the river basin water management system, producing a "black swan" event – a bad surprise that could have been anticipated. These findings have broad implications for ongoing renegotiation of the Canada-US Columbia River Treaty and to new approaches for studying the response of large infrastructure to climate change.

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1258

Water use and water use efficiency of Eucalyptus and Pinus plantations modelled using CABALA, 3PG and WAVES

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The effect of plantations on water balance in the "Cordillera de Costa" is a sensitive resource management issue for Chile. Over the last ten years components of the water balance have been measured in catchments and plots covered by Eucalyptus and Pinus plantations and native forest from Constitucion in the North (average annual rainfall 850 mm) to Valdivia in the south (2450 mm). Inevitably and in common with all empirical water balance studies, these data cover a limited range of climate, soils and forest management. Managing the trade-off between wood production and water security will require the application of models to the analysis of scenarios, including future climates, alternative landscape designs and silviculture, that are beyond the range of existing measurements. There are many models available and they vary in the complexity of their representation of the effect of soils, climate and forest management on forest growth and water balance and hydrology. This paper compares outputs of three single cell models with observations of growth and water balance made in plantations and native forest. 3PG is a general model of plantation growth and a powerful management tool when coupled with local observations of growth. CABALA emphasises the effect of management and climate on canopy structure and function and was developed to provide silvicultural decision support. WAVES includes a more detailed description

of sub-surface water movement than either 3PG or CABALA. 3PG has been widely adopted by plantation growers in South America. Nonetheless, we argue that augmenting the existing application of 3PG with other models that have a more realistic representation of sub-surface processes and the effect of climate and management on canopy processes, will enhance confidence in predictions of the effect of land use change on water resources.

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919

IMPACT OF LAND-USE CHANGE ON VALDIVIAN TEMPERATE FOREST AND ITS ECOSYSTEM SERVICES: BASIS FOR PLANNING DECISION-MAKING

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Land-use change impacts biodiversity and ecosystem services, which are intrinsically related. There is a serious lack of knowledge concerning on how land-use change affects this relationship at landscape level, where the greatest impacts have been reported. A proper knowledge of that relationship would provide crucial information for planning conservation strategies. The forest landscape of southern Chile, which includes Valdivian Temperate Forest, has been designated as a hotspot for biodiversity conservation. However, this landscape has been transformed by land-use change. We evaluated the impact of land-use change on the spatial patterns of the diversity of native forest habitat and the influence of these impacts on the provision of the ecosystem services water supply, erosion control, and organic matter accumulation from 1986 to 2011. The evaluation, at the landscape level, was carried out using satellite images, landscape metrics, spatially explicit models and generalized linear models. We found that the area loss of native forest habitat was 12%, the number patches of native forest habitat increased more than 150% and the Shannon diversity index decreased by 0.20. The largest decrease in the provision of services was recorded for erosion control (346%), and the smallest for water supply (11%). The loss of provision of the ecosystem services can be explained by the interaction between the area loss, increase in the number patches and diversity loss. We recommend that the planning decision-making should consider the current landscape configuration, complemented with land-use

planning. We suggest that these efforts must be an integral part of environmental policies that need to be generated by the Chilean government.

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1126

SIMPLE UPSCALING TO BRACKET ESTIMATES OF WATER YIELD CHANGE DUE TO FOREST MANAGEMENT

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Blöschl suggested in 2004 that scaling may emerge as a unifying theory in hydrology, but he also cautioned that the pioneers of scaling were not field hydrologists. Defining dominant hydrologic processes at multiple scales in a forested environment requires linking observations to their underlying processes and finally to system models. These can include understory adaptation, hydraulic redistribution, precipitation feedback, and soil changes with plant growth and management, among other processes. We clearly cannot simulate these processes, bur can apply simple techniques to get a more realistic view of upscaled effects for, in effect, field knowledge. A study investigated the potential effects of forest understory removal or forest replacement for a dedicated energy crop (panicum virgatum) on water quality and hydrology in the Southeastern US and found that both direct measurement and stand-level simulations yielded results at a point of maximum effect. However, the possibility of total landscape conversion to intercropping or replacement became a major public concern. While forest ownership patterns and management practice timing attenuate effects in a manner obvious to a timberlands manager, landscape outcomes need to be modeled for a broader audience. In this study calculated and measured changes in ET for bioenergy land use alternatives were compared with known relationships between Leaf Area Index (LAI) and evapotranspiration (ET) across stand age in a managed forest. Water yield was computed at a stand scale for different management practices and rainfall regimes, and then aggregated using multiple scaling thresholds to estimate the water yield response to both reasonable and extreme bioenergy scenarios. Although this land use change has a clear baseline, that is not always the case when evaluating effects of modern forest management. The study was extended to look at even-aged forest management in comparison to uneven-aged management and unmanaged stands that retain a more constant water demand. Basing simulation on actual ownership and management timing gives context to modeled and observed effects of forest management at a landscape scale.

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1050

FERTILIZATION BY CARBON DIOXIDE PLAYS A MINOR ROLE IN LONG-TERM GROWTH PATTERNS OF SCOTS PINE IN MIXEDWOODS AT THE PYRENEES

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A factorial simulation experiment was carried out with the FORECAST Climate ecological model, calibrated for two different Scots pine / European beech mixed forests (one continental, another one Mediterranean) in the Southwestern Pyrenees (Spain) to isolate the individual influence of three growth limiting factors: nutrient availability (represented by N available in soil), climate (water availability and growing season length) and carbon (atmospheric CO2 concentration). The simulations switched off alternatively each limiting factors, and then running the simulations with all of them on or off simultaneously. This approach allowed isolating and ranking the influence of each limiting factor. A moderate (RPC 4.5) climate change scenario was simulated using estimates from six different major climate models. To account for site influence, simulations were repeated for both Mediterranean and continental research forests. It was estimated that accounting for climatic limitation (precipitation and temperature) reduced potential C accumulation at ecosystem level by 12.7%, whereas nutrient limitation accounted for 1.8%, and CO2 fertilization accounted for a mere 0.3% increase in ecosystem C. On the other hand, at the Mediterranean site, nutrient limitation was the most important factor, reducing potential ecosystem C by 11.5%, whereas climate limited 8.4% and CO2 fertilization increased ecosystem C by 0.6%. When the three factors were simulated simultaneously, they accounted for a reduction of 10.2% and 12.9% of ecosystem C at the continental and Mediterranean forests, respectively. These results indicate that the CO2 fertilization effect, while positively affecting ecosystem C accumulation, it can counteract only a minor part of the growth limitation imposed by nutrients and climate. In addition, our results indicate that forests are acclimated to their past and present limiting conditions, and if they change owing to anthropic activities, trees will not be ready to cope with such change, even if they have to potential to do so.

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1139

MODELOS DE CAUDAL ESTIVAL EN BASE A VARIABLES ECOHIDROLÓGICAS ASOCIADAS A BOSQUE NATIVO, PLANTACIONES DE PINUS RADIATA Y EUCALIPTUS GLOBULUS EN CUENCAS DISTRIBUIDAS ENTRE EL BIO-BIO Y LA ARAUCANÍA.

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La escorrentía es un fenómeno multi-escala, y su estudio requiere distintos enfoques metodológicos. En el presente estudio, se desarrolla una metodología alternativa a los clásicos métodos usados en la hidrología forestal. En base a variables ecohidrológicas asociadas a las coberturas de Bosque nativo y plantaciones comerciales (Pinus radiata y Eucalyptus globulus), en cuencas distribuidas entre las regiones del Bío-Bío y la Araucanía, se generó modelos de densidad de probabilidad para los caudales estivales (m3/día). Las variables ecohidrológicas provienen de modelos de elevación digital de las cuencas en estudios, índices vegetaciones de imágenes satelitales (Landsat 7) y 615 registros de caudales estivales en cuencas monitoreas entre el 2012 y el 2016, con 194 puntos de medición de caudales, asociadas a tamaños de cuencas 100 ha. Si bien existe una alta variabilidad en los caudales estivales, fue posible modelar las frecuencias de estos caudales y diferenciarlos por tipos de cobertura (Bosque Nativo, Pinus radiata y Eucalyptus globulus), mediante modelos de densidad de probabilidad exponenciales. Posteriormente, se evaluó el grado de correlación entre los parámetros de describen estos modelos de caudal, con la precipitación y los índices vegetaciones de las Cuencas en estudio, obteniendo R2 promedios de 0.9768 en Bosque Nativo), 0.9913 para bosques de Pinus radiata, y 0.9924 para bosques de Eucalyptus globulus. Se atribuye una mayor variabilidad en Bosque nativo debido a la estructura vertical de estos bosques, mientras que en plantaciones, la estructura y la canopia de estos bosques es más homogénea, permitiendo valores altos en R2. Posteriormente, se evaluó la robustes de los modelos generados por tipos de cobertura, al simular muestreos bootstrap para construir intervalos de confianza para los caudales estivales por tipos de cobertura. El estudio permitió comprender mejor la relación entre los caudales estivales y las variables de las coberturas boscosas asociadas a las cuencas monitoreadas dentro del patrimonio.

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941

SNOWFALL INTERCEPTION IN A DECIDUOUS NOTHOFAGUS FOREST AND IMPLICATIONS FOR SPATIAL SNOWPACK DISTRIBUTION.

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Native Nothofagus forests in the mid-latitude region of the Andes Cordillera are notorious biodiversity hotspots, uniquely situated in the southern hemisphere such that they develop in snow-dominated reaches of this mountain range. Spanning a comparatively smaller surface area than similar ecosystems, where forests and snow coexist in the northern hemisphere, the interaction between vegetation and snow processes in this ecotone has received relatively lesser attention. We present the first systematic study of snow-vegetation interactions in the Nothofagus forests of the southern Andes, focusing on how the interplay between interception and climate determines patterns of snow water equivalent variability. The Valle Hermoso experimental catchment, located in the Nevados de Chillán vicinity, was fitted with eight snow depth sensors that provided continuous measurements at varying elevations, aspect and forest cover. Also, manual measurements of snow properties were obtained during snow surveys conducted during end-of winter and spring seasons for three years, between 2015 and 2017. Each year was characterized by distinct hydrological conditions, with 2016 representing one of the driest winters on record in this region. Distance to canopy, leaf area index (LAI) and total gap area were measured at each observational site. A regression model was built based on statistical analysis of local parameters to model snow interception in this kind of forest. We find that interception implied a 22.3% reduction in snow accumulation in forested sites compared with clearings. The interception in these deciduous trees represents, on average, 23.6% of total annual snowfall, reaching a maximum measured interception value of 13.8 mm SWE for all snowfall events analyzed in this research.

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1068

Using shifting species distribution models to inform rainfall runoff models

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Spatial patterns of land cover affect the spatial heterogeneity of hydrological processes. However, rainfall-runoff models typically model weather and climate effects on streamflows, treating land cover as a static parameter. Climate change is predicted to affect the distribution of tree species and forests in mountain regions. Climate change effects may be especially acute in mountain environments, forming 'sky islands', as warming temperatures drive montane and alpine ecosystems upslope, resulting in tree mortality at the lower margins of their distribution. Understanding how the distribution of forests might respond, expand, or compress is important for forest and water management. To describe spatial extent of vegetation communities, species distribution models (SDM) were used to estimate conditions across a landscape from conditions with known occurrences of a species. We sampled across the landscape in Chile's Nevados de Chillán watershed identifying forest (e.g. Nothofagus), shrub and grass communities (e.g. Adesmia, Nassauvia) and quantified the corresponding environmental conditions from digital layers. A Random Forest statistical classifier was used to build SDMs from topographic surrogates (e.g. elevation as a surrogate for temperature) and predict future distributions using anticipated climate change conditions. Stream runoff and snowmelt were then estimated using a rainfall-runoff model under current and future species distributions to identify changes to the timing and quantity of runoff as new plant communities displace disturbed forests. While vertical migration of species is complex and factors such as the development of new soils at treeline is poorly understood, our work examines likely forest and streamflow effects due to species distribution shifts, and will greatly aid land and water managers in planning for future change.

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1277

Assessing spatio-temporal impacts of global change on water and biomass production processes at catchment scale: a synergistic approach based on remote sensing and coupled hydrological models to impro

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In forest plantations, management decisions to increase the productivity and the economic benefit of biomass production can notably affect ecosystem functioning entraining severe consequences especially under scarce resource scenarios due to global changes. We hypothesize that "the scenarios of global change under the current management dynamic of forest plantation monoculture are susceptible to drive ecosystem services to collapse and thereby impacting significantly the production of water and biomass at the watershed scale". The general goal of this research is to "identify and analyze the spatio-temporal impacts of global change on water and biomass production in managed forest ecosystems at the watershed scale". The study is located in the Cauquenes rainfed watershed located in South-Central Chile, where the main land cover classes are pine plantation, shrubland, vineyard, pastures and native forest. The specifics goals are: (1) Identify the processes that define the spatio-temporal variability of water and biomass production at the watershed scale; (2) Implement and evaluate different hydrological modelling approaches to represent the main processes that controls the production of water and biomass; The SWAT hydrological model and the HYDRUS-1D soil water transfers model, representing the watershed and the local scale will be calibrated with streamflow and soil moisture data respectively and will be run independently. To couple the models we proposed to (3) develop a multi-objective calibration procedure with the Particle Swarm Optimisation procedure. (4) Quantify the production of water and biomass for different land covers, using simulations of the coupled models and validated against streamflow and soil moisture. (5) Quantify the differences between biomass and evapotranspiration values obtained with hydrological simulations against estimations derived from remote sensing techniques. Biomass will be estimated from high resolution multi-spectral stereoscopic data, and LiDAR airborne archive data. Actual Evapotranspiration will be estimated by residual approaches based on thermal and spectral satellite data. (6) Quantify the impacts on biomass and water production of different land use and climate change scenarios. The scenarios of future land cover and land use will be obtained following a statistical modelling approach (Dyna-CLUE) fed with remote sensing classification techniques. The climate change scenarios will be obtained from the recent available downscaled prediction for the region. Future scenarios of water and biomass production at the local and

watershed scale will be obtained from the coupled HYDRUS-1D/SWAT model simulations.

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948

Caracterización de los parámetros morfométricos de cuencas andinas relacionados a crecidas

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Con el objetivo de conocer la morfometría de las subcuencas andinas: Longaví, Renegado, Diguillín y Lonquimay se calcularon y caracterizaron los parámetros morfométricos de pendiente media, área, exposición, índice de Gravelius, factor de forma, densidad de drenaje, longitud del cauce principal y el orden de los cauces, parámetros estrechamente relacionados a crecidas de caudal. Para la obtención de ellos, se utilizó el software ArcGis con su extensión ArcHydro, en su versión 9.3. El procesamiento de modelos de elevación digital, shapes e imágenes satelitales de las subcuencas andinas arrojó que el factor de forma de las cuatro cuencas presentó resultados bajos (inferiores a 1) estando menos sujetas a crecidas que una de la misma área y un factor de forma mayor. A su vez, el coeficiente de Gravelius también resultó en valores lejanos a 1, lo que indica volúmenes de concentración de agua bajos. Diguillín por su parte, tuvo una mayor longitud de todos sus cauces, lo que hace a esta cuenca una cuenca muy activa (hidrológicamente) en relación a las tres restantes. A partir de lo anterior, durante un mismo evento de tormenta de igual intensidad, Renegado, Lonquimay y Longaví mostrarán tiempos cortos de retraso en las cuencas en comparación con Diguillín, bajo similar humedad del suelo. Se puede concluir por tanto que Longaví, Renegado y Lonquimay son cuencas que están pobremente drenadas, sin embargo, Longaví mostrará una mayor velocidad en su caudal con una pendiente media de un 48,03% y un menor tiempo de concentración, seguido por el 44,47% de Diguillín, Renegado con 30,87% y Lonquimay 29,29%. Las cuatro cuencas cuentan con una mayor exposición sur. A partir de los resultados obtenidos se infiere que ninguna de las cuatro cuencas presentaría una potencial amenaza frente a episodios de crecida por algún evento de lluvia de mayor intensidad.

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909

Metodología para el uso de redes neuronales artificiales en la predicción de variables hidrológicas: Una revisión

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Las complejas relaciones que ocurren en una cuenca hidrográfica no son una tarea sencilla de modelar y comúnmente se emplean modelos conceptuales que requieren una gran cantidad de información; ante esto, las Redes Neuronales Artificiales (ANNs) constituyen un enfoque alternativo en la modelación hidrológica. Generalmente, las redes neuronales se emplean para el pronóstico de variables hidrológicas como un complemento para la prevención de posibles inundaciones. Una exploración preliminar en el uso de estos modelos, ha puesto en evidencia la falta de una metodología clara para su aplicación. Por esta razón, la investigación tiene como objetivo principal establecer lineamientos y recomendaciones para el uso de redes neuronales. En este sentido, se presenta una revisión de literatura fundamentada en el estado del arte y casos de estudio enfocados en redes neuronales con arquitectura perceptrón multicapa combinada con el algoritmo de aprendizaje retro-propagación para la predicción de caudales. De manera que, se han analizado un total de 40 artículos científicos realizados entre 1995 – 2017 y que han sido publicados en 21 revistas indexadas por Scopus o Latindex. Cada uno de los artículos fueron clasificados mediante cuatro categorías (área de estudio, variables hidrológicas, base de datos y parámetros ANN) que incluyen 19 criterios. Esto ha sido la base para fijar una metodología y recomendaciones orientadas hacia el procesamiento de datos, selección de parámetros e implementación del modelo matemático para futuras aplicaciones de redes neuronales.

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1029

Calibration and validation of Budyko framework to watersheds in southeastern Brazil

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This study applied the Budyko framework (Budyko, 1948, 1974) to understand the impacts of climate change over the water yield of streams in Southeastern Brazil.

Data from 29 different catchments throughout the state of São Paulo could fill at least 10 complete years of observations. Mean annual precipitation ranged from 1200 to 1800 mm and the average annual runoff represented 20 to 50 % of the annual precipitation across all sites. Fu´s model (1981) was used in the form proposed by Zhou et al. (2015) written as: R/P=(((1+ (PPET)^(-m))^(1/m))- (P/PET)^(-1)); where the parameter m is dimensionless and determinates the shape of the response curve. Time series stream flow measurements were provided by the state department of water and electric energy of Brazil (DAEE). Rainfall and evapotranspiration data came from two different sources. Xavier et al. (2016) gridded database (0.25° resolution) was set as the reference source but was available from 1980 to 2013. Nasa´s POWER product was used to fill the 2014 to 2016 period, using specific calibration coefficients for each watershed. All variables were integrated from monthly to annual level. The model was highly significant at all sites, with m values ranged from 1.5 to 3 with 2.4 as the adjusted global value and despite the nonlinear relationship, the greater the parameter is, lower is the ratio R/P . The parameter had strong positive correlation with stream density (km stream/km²) and minimum elevation. Indicating that denser drainage meshes and higher altitudes provides a more stable water flux with lower R/P ratio. We conclude that the model proposed was able to capture the differences among watersheds enabling simulations under climate change scenarios. Once the model was validated, further steps in this research will cover these simulations.

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1016

Moderate increases in runoff after forest harvesting: the contrasting effects of tree cutting and long term drought

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Eleven experimental catchments located on eastern aspect slopes of the Coastal Mountain Range near the city of Nacimiento (37° 28" S, 72° 42" O) have been monitored since 2008 to study water and forest plantations issues. The experimental units are situated in Forestal Mininco S. A. properties, comprise 7 individual catchments and 2 pair of nested catchments and have areas between 7.7 y 414 ha. We present results of flow variation after forest harvesting in 5 catchments. Forest clearcuttings of 84-90% of total catchment area generated moderate increases of 113-230 mm/year and of the order of 37-66 mm/year when the tree species in the harvested plantations were P. radiata and E. globulus, respectively, and these increases were noticeable only up to 2-3 years after harvesting. When the total clearcut area was less than 51% of total catchment area no changes in runoff were

perceptible, a significant increase from the 20% value often referred to in the scientific literature. The study period is characterized by lower than average annual precipitation as only year 2014 had an annual rainfall above the long term average for the Nacimiento zone, a condition which is certainly reducing underground water storage. Climate, and not only forest operations, forest cover, tree species composition, soils characteristics and site preparation techniques, must therefore be consider in explaining runoff conditions in the study catchments. This is supported by the observation that runoff in catchments under different forest covers and species but with area less than 13 ha is becoming ephemeral in summer and for periods that lengthen as the investigation develops. Likewise a catchment of 41 ha with a 45% cover of native forest is experiencing a noticeable decrease in runoff at a rate comparable to the flow increases after harvesting in other units.

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1079

Intra-specific and inter-specific variations of leaf wax fatty acid from three plants in riparian ecosystem from temperate forest

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Plants in altitudinal gradients are exposed to changing environmental conditions that become harsher as altitude increase. To protect themselves from these conditions plants can change their leaf wax composition. We provide here the distribution and abundance of leaf wax fatty acids (FA)(>C24) of three species (Araucaria araucana, Chusquea sp. and Nothofagus dombeyi) from the temperate forest in riparian ecosystem at lakes from different sites, with a specific focus on changes in altitude. Additionally, through statistical regression and correlations we investigated leaf wax FA response to environmental conditions (i.e. altitude, mean annual temperature [MAT] and mean precipitation [MAP], aridity).The intra-specific distribution of FA does not have a significant linear relationship with altitude, however, we find significant inter-specific differences. The distribution of leaf wax FA allows us to differentiate between the species: Chusquea sp. (C24-C38), A. araucana (C24-C36) and N. dombeyi (C24-C34) as well the carbon preference index (CPI) and average chain length (ACL), identifying A. araucana with the highest values. The environmental variables related to climate were mainly correlated to the abundance of leaf wax FA and precipitation of the last five years was the most highly correlated variable. The results reported here provide valuable information on the distribution of leaf wax FA of plants in riparian ecosystem from the

temperate forests in South America, which are of ecological and geological interest.

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1105

Natural restoration might be more suitable in China's Loess Plateau- a case study for two typeical restoratoin species

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China's Loess Plateau is one of seriously eroded areas in the world and large-scale revegetation activities have been implemented across this region to control soil erosion. However, irrational restoration approaches has caused significantly negative consequences, such as soil drying and streamflow declining. Vegetation suitability research would provide guidance for rational distribution of vegetation restoration, which has important significance for the sustainability of vegetation restoration in the Loess Plateau. Optimality trade-off hypothesis state that dryland vegetation patterns are constrained by maximization of water use and simultaneous minimization of water stress. Thus, we developed individual species fitness equation to quantify vegetation suitability, which is defined on an optimality trade-off hypothesis.The vegetation suitability of artificial restoration species (Robinia pseudoacacia)and natural restoration species (Stipa bungeana) were compared. Results showed that Robinia pseudoacacia generally suffered greater water stress than the Stipa bungeana. Stipa bungeana generally has greater water use efficiency than Robinia pseudoacacia. In most regions of Loess Plateau, vegetation suitability of Stipa bungeana is higher than Stipa bungeana. Our findings indicate that natural restoration might be more suitable than artificial restoration in the Loess Plateau, and species selection should be applied with more caution.

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1352

Evaluation of the differences between the components of the water balance between scrub and plantations of Pinus radiata

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The land use and land cover changes in the Maule region has been modified mainly by the expansion of agriculture and forest plantations, covering 40% of the actual area. Maule is one of the three regions of the country with the highest percentage of forest plantation cover. The forestry policy 2015 - 2035 proposes to incorporate small and medium-sized owners into the forest sector, who mostly own areas covered with shrublands. However, the effect of land cover changing on the water balance has been scarcely studied. This study aims to assess and compare the water consumption of shrubland and Pinus radiata plantation in a rainfed watershed of south central Chile. The study area will be in the Cauquenes river basin, analyzing 7 repetitions for each land cover. The quantification of water consumption will be based on the HYDRUS-1D water transfers process base model Simulation of transpiration will be compared against the in-situ measurements of transpiration obtained through a Sap Flow system. The volumetric soil water content for the calibration procedure will be monitored through a FDR probe every month for a complete year. Leaf Area Index to parameterize the model will be determined through the "Plant Canopy Imager". Physical properties of soils such as bulk density, soil depth, textural class, organic matter, stability of aggregates, water content at field capacity and permanent wilting point will be collected in the field and analyze in laboratory to compare the land cover condition and to parameterize HYDRUS-1D.

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960

Effect of intensive management forestry on headwater catchments, application of the TETIS® model

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ABSTRACT Hydrological models that use spatially distributed information are a useful tool to analyze the dynamics of drainage catchments and simulate change scenarios. In this work, we apply the hydrological model TETIS® to analyze the effect of intensive management forestry practices on headwater runoff, with special attention to summer flows, all in a framework of climate change modeling. For modeling, flow series obtained in ten catchments (catchment area 7.1 to 411 ha) located in the Chilean Coastal Range, region of Biobío were used (37° 28' S, 72° 42'

W). Six of these catchments drain independently (N02, N03, N04, N05, N07 and N11), and two pairs of catchments are nested (N06-N08 and N09-N10), monitored between the years 2008 and 2015, with this data has been calibrated the model and its results have been validated. The runoff of the catchments varies between 183.9 and 395.0 mm with a runoff coefficient between 0.11 and 0.46. Once the model was calibrated, several land use change scenarios and different climate scenarios were simulated. The climate scenarios were provided with information until the year 2050 of the last IPCC report (2013), combining different planting percentages between 27 and 90%, harvest between 0 and 10.3%, roads between 1.3 and 2.8% and native forest between 6.1 and 64.4%, with 5%, and 20% less precipitation and a temperature increase of 1 °C, 3 °C and 5 °C. The main conclusions of this study are: i) changes in land use (i.e. increment of plantation areas) in the catchments led to an increase of lows and ii) on the other hand, changes in climate, based on a decrease in annual precipitation and an increase in temperature, resulted in a decrease in flow. KEYWORDS: Forestry, summer flows, TETIS® hydrological model; Climate change.

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1269

Cartografía de daños por 'Candidatus Phytoplasma pini' sobre masas de Pinus halepensis Mill. a partir de información del sensor MSI-Sentinel 2A

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En el proyecto se integró la información procedente de campo, información proporcionada por el sensor MSI-Sentinel 2A e información auxiliar fisiográfica para la generación de cartografía de daños por afección de 'Candidatus Pythoplasma pini' en las masas de pino carrasco (Pinus halepensis Mill.) localizadas en el marco geográfico del complejo de la Hoya de Guadix-Baza y la vertiente Norte del macizo de Sierra Nevada (España). Del trabajo de campo se obtuvo información de Porcentaje de Defoliación, como principal daño por afección de 'Candidatus Pythoplasma pini' en distintas parcelas de muestreo. Para el posterior análisis de obtuvo información de las bandas espectrales del sensor MSI-Sentinel 2A, los índices de vegetación calculados a partir de los y de la información fisiográfica (pendiente, orientación y altitud) de dichas parcelas. A partir de estas variables se generó un modelo explicativo de defoliación. Para la generación del modelo se empleó el método no paramétrico kNN (k-nearest neighbours). Previamente, se realizó una selección de variables donde se determinó que las bandas B8 y B12, los

índices de vegetación RENDVI (Sentinel Red-Edge) y GNDVI, la pendiente y la altitud eran las variables con mayor importancia para la obtención del modelo de defoliación. El método seleccionado fue kNN- msnPP ya que fue el que presentó los menores RMSE, BIAS y MAPE. El resultado del trabajo es la cartografía de daños donde se puede ver que el 95% de las masas de pino carrasco estudiadas presentan daños por este fitoplasma, presentando el 33% de la superficie daños de defoliación superior al 75%.

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1271

Comparativa de los errores obtenidos en un inventario LiDAR por variables de masa y de árbol individual en un plantación de Pinus radiata en Chile

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La tecnología LiDAR ha supuesto una revolución en la evaluación de recursos forestales. Esta tecnología se puede aplicar por variables de masa o de árbol individual. Los costes de aplicación de la metodología de árbol individual son mayores que los métodos de masa, principalmente derivado del mayor nivel de procesamiento y calidad de la información requerida en el trabajo de campo. En este trabajo se han comparado los resultados de las estimaciones por ambos métodos en una misma zona de estudio, siempre para estimaciones a nivel de masa sobre celdas de 500 m2. Los resultados muestran que tanto el área basimétrica (G) como el volumen (V) presentan EAM inferiores para métodos de masa que con métodos de árbol individual (21.3% frente a 27% para G; 16.4% frente 24.8% para V). Sin embargo, la altura dominante se obtiene con mayor precisión con métodos de árbol individual (3.8% frente a un 4.7%).

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998

Modelling the Effect of Changing Precipitation Inputs on Deep Soil Water Utilization

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Forests in the southeastern United States are predicted to experience future changes in seasonal patterns of precipitation inputs as well as more variable precipitation events. These climate change-induced alterations could increase drought and lower soil water availability, therefore alter rooting patterns and increase the importance of deep roots that access subsurface water resources. To address forest response to drought in both deep rooting and soil water utilization, we utilize a throughfall reduction experiment in a loblolly pine (Pinus taeda L.) plantation of the southeastern United States to calibrate and validate a hydrological model (HYDRUS 1-D). The model was calibrated against field measured soil moisture data under ambient rainfall and validated using 30% throughfall reduction data. Using this model, we tested these precipitation scenarios: (a) evenly reduced; (b) less in summer, more in winter; (c) same total amount with less frequent but heavier storms; and (d) shallower rooting depth under the above 3 scenarios. Under the first scenario, drainage decreased proportionally much faster than evapotranspiration, implying plants will acquire water first to the detriment of drainage. When precipitation was reduced by more than 30%, plants relied on stored soil water to satisfy evapotranspiration suggesting 30% may be a threshold that if sustained over the long term would deplete plant available soil water. Under the third scenario, evapotranspiration and drainage decreased, whereas surface run-off increased. Model indicated gains in evapotranspiration with deeper roots under evenly reduced precipitation and seasonal precipitation redistribution scenarios but not when precipitation frequency was adjusted. Deep soil and deep rooting can provide an important buffer capacity when precipitation alone cannot satisfy the evapotranspirational demand of forests. How this buffering capacity will persist in the face of changing precipitation inputs, however, will depend less on seasonal redistribution than on the magnitude of reductions and changes in precipitation frequency.

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1332

MOVIMIENTO DE AGUA A LO LARGO DE UNA LADERA DE BOSQUE NATIVO EN LA CORDILLERA DE LA COSTA DE LA REGIÓN DEL MAULE

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En Chile existen diferentes paisajes con características y dinámicas propias, entre los que se encuentran los ecosistemas de la Cordillera de La Costa, particulares desde el punto de vista hídrico y vegetacional dado el régimen de alimentación pluvial que presentan. La cuenca del río Cauquenes ubicada en la séptima región del Maule, ha sufrido una constante presión histórica a causa de los cambios en el uso de suelo. Su territorio está siendo utilizado en gran parte por plantaciones forestales de Pinus radiata D. Don (pino), y viñas de riego y secano, siendo escasos los parches de bosque maulino y esclerófilo que quedan. Los estudios en Chile sobre bosque nativo y agua resultan insuficientes para comprender las interacciones dentro del sistema. Es por ello que la presente investigación busca estudiar el movimiento de agua en una ladera de bosque nativo en la cuenca del río Cauquenes. Se medirá la humedad de suelo a 1.5 mt. de profundidad aprox. en tres puntos a lo largo de un perfil longitudinal, realizándose mínimo tres veces en el año: antes, durante y después de un evento de precipitación. Todo con el fin de entender el comportamiento del agua en su movimiento por el suelo, y así identificar la influencia de ciertos elementos del ecosistema, como suelo y vegetación, en el ciclo hidrológico.

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1057

HYDROLOGICAL FUNCTIONS ASSOCIATED TO LITTER DEPOSITION IN ATLANTIC FOREST UNDER SECONDARY SUCCESSION

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Forest litter plays an important function regulating superficial hydrological process, mainly the protection of the first layer of soil. Hydrological functions of the litter were investigated on Atlantic forest at different stages of secondary succession in the southeastern Brazil, comprehending five different age stages that were analyzed as groups: 8-16 years; 16-21 years; 21-38 years; 38-54 years; and reference (> 54 years). Litter samples were collected in 38 plots of 0,0625m² randomly spread among the groups and processed by Blow method to obtain the water holding capacity and biomass. We characterized the forest structure through basal area and Leaf Area Index (LAI). There was no statistical difference of accumulated biomass among the forest age groups, but the reference (> 54 years) delivered higher values than all others. We found a correlation between the biomass and water retained in the litter, and the reference also presented the highest absolute values of water retained. However, comparing the water holding capacity, 8-16 years group had the highest values whereas the reference presented lower capacity. This could be explained

by the litter stage of decomposition, where advanced stages could have hydrophobic compounds. The role of chemical composition is discussed in order to understand this effect. In any case, the values of water holding capacity were considered higher than other studies, presenting values varying from 140% to 430%, which highlights the litter importance on superficial water processes.

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1182

ECOSYSTEM SERVICE IN ADAPTATION TO CLIMATE CHANGE IN PANCHASE MOUNTAIN ECOLOGICAL REGIONS OF NEPAL

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Rural mountain communities in developing countries are considered particularly vulnerable to environmental change, including climate change. Forests and agriculture provide numerous ecosystem services to local communities and can help people adapt to the impacts of climate change. There is however poor documentation on the role of ecosystem services in people's livelihood and adaptation practices. This study in the rural Panchase Mountain Ecological Region of Nepal identifies practices being used to adapt to a changing climate through key informant interviews and focus group discussions. At the household level, livelihood diversification, changes in cropping patterns and farming practices, use of multipurpose plant species and income-generation activities were identified as adaptation strategies. Among major strategies at the community level were community forestry-based climate adaptation plans of action for forest and water resource management. Landscape-level adaptation strategies were large-scale collaborative projects and programs, such as Ecosystem-based Adaptation and Chitwan Annapurna Landscape conservation; which had implications at both the local and landscape-level. A proper blending and integration of adaptation strategies from individual households through to the community and to the landscape level is needed for implementing effective adaptation in the region.

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1049

APPLICATION OF TREND ANALYSIS TO EXPLORE HYDROLOGICAL VARIATIONS UNDER CLIMATE CHANGE IN THE TAIMALI STREAM BASIN, TAIWAN

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Due to the climate change and the extreme weather events, the precipitation in Taiwan has changed very dramatically. The hydrological variations in a basin are highly related to the weather condition. In order to identify the effect of the climate change on hydrological variations, we assess annual, seasonal and monthly trends of precipitation, stream runoff, and sediment load. The period of analyzed precipitation data was from 1981 to 2012, stream runoff data was from August in 1983 to July in 2009, and sediment load data was from 1984 to 2008 in the Taimali stream basin, southeastern Taiwan. The Mann-Kendall trend test and the Theil-Sen slope test were applied for trend analysis in this study. The results show that the precipitations of annual, wet period, autumn season, and in August have significant increasing trends. The τ values are 0.29, 0.27, 0.25, and 0.23, respectively. The stream runoffs of annual and autumn season also have significant increasing trends. The τ values are 0.27 and 0.24, respectively. In addition, the sediment loads of annual, wet period, and autumn season also have significant increasing trends. The τ values are 0.27, 0.25, and 0.25, respectively. Through the trend analysis, we can identify that the hydrological conditions in the Taimali stream basin are strongly affected by the climate change. It causes the annual precipitation, stream runoff, and sediment load significantly increasing, especially for the autumn season and wet period with obvious increasing trend.

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ID 993

INTERSPECIFIC VARIATION IN HYDRAULIC REDISTRIBUTION AND ITS IMPORTANCE TO PLANT COMMUNITIES

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Trees can regulate water availability among their rooting strata through a nocturnal, passive transference of water known as hydraulic redistribution (HR). In systems with highly partitioned water resources, species with access to a reliable source of deep groundwater may redistribute that water in shallower rooting zones. The redistributed water may be taken up by shallow-rooted understory plants, reducing water stress. The longleaf pine [Pinus palustris Mill. (Pinaceae)] forests of the southeastern U.S. are an ideal system to investigate how HR can affect understory plants. These ecosystems are often characterized by xeric, well-drained soils, relatively shallow water tables, and high herbaceous diversity. The goal of this study was to quantify HR in three tree species and determine if it provides an ecologically important water subsidy to understory plants. We used the heat ratio method to estimate nocturnal sap-flow from tree roots to soils in longleaf pine and two co-occurring Quercus

species. We used trenched plots to isolate understory plants from the rooting network of deeply rooted tree species. In trenched plots, we compared soil moisture content, and both pre-dawn and mid-day understory plant water potential. Lastly, we used stable isotopes of soil and plant water to determine major water sources for tree and herbaceous species. We found that HR was up to 4-times higher in P. palustris than in Quercus. HR did not affect soil moisture or mid-day plant water stress, but significantly reduced ($p < 0.001$) pre-dawn leaf water potential. However, isotopes indicated that while shallow groundwater was a major water source for tree species, it was not a major water source for herbaceous cover. While HR fluxes were substantial and this had some short-term effects on understory plant stress, future research will determine long-term effects of HR on understory communities under a wider range of climate conditions.

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ID 1158

LONG-TERM ENHANCED NITROUS OXIDE EMISSION AND REDUCED METHANE UPTAKE AFTER CLEAR CUTTING FROM A TEMPERATE SPRUCE FOREST SOIL

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Better understanding how greenhouse gas (GHG) emissions respond to typical forest management practices such as clear cutting and selective cutting is a prerequisite to calculate overall forest GHG budgets. However, most available studies are short term, do not cover entire years or do report only on one or two GHGs, so that the long-term effects of forest management practices on the overall GHG balance including CO2, N2O and CH4 remains uncertain. This study, reports on 13 years continuous, sub-daily measurements of soil N2O and CH4 fluxes and ecosystem CO2 exchange of a temperate spruce forest in Southern Germany and assesses how clear cutting and selective cutting affected the overall GHG balance. Based on these measurements and by integrating modelling approaches, we calculated the GHG balance for a full rotation period of 100 years. The effects of clear cutting on soil N2O and CH4 fluxes were significant for at least 10 years after logging, with soil N2O emission being increased on average by 147.6% and CH4 uptake being reduced by in average 54.8%, respectively, as compared to the control site during the entire observation period. Selective cutting showed a much less significant impact on soil N2O and CH4 fluxes, with effects diminishing 2-3 years after removal of part of the trees. Increased soil water content, enhanced soil C and N cycling and shifts in microbial populations involved in N cycling were found to be responsible

for the observed changes in soil N2O and CH4 fluxes. Overall, selective cutting turned out to be the forest management strategy with the lowest cumulative soil GHG emissions, while clear cutting and associated multi-year increases in soil N2O emissions and reductions of the soil CH4 oxidation activity reduced the overall GHG sink strength of the forest over the entire rotation period by 3%.

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1172

ANALYSIS OF CHANGES IN THE BRAZILIAN FOREST CODE IN PERMANENT PRESERVATION AREAS OF TOP HILLS, MOUNTAINS AND MOUNTAINS RANGES

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Ecosystem services provided by natural areas such as hydrological regulation, atmospheric regulation, erosion control, pollination and control of agricultural pests are essential for the present and for the future society as well as to the sustainability of production systems. Until the year 2012, Brazilian forestry legislation was governed mainly by Law 4,771 1965, but this was significantly modified as of the publication of Federal Law 12,651/2012. The change made in the Forest Code has caused profound changes in two of the most important instruments established by the norm: The Permanent Preservation Area (PPA) and the Legal Reserve (LR). The objective of this study was to analyze the effects generated by the new law with the amendments made in the PPA of Top Hills, Mountains and Mountains Ranges under the system of São Paulo State Environmental Licensing in its first application of four years (May / 2012 - May / 2016) and its impact on the conservation of natural resources. To represent the data were adopted the Hydrographic Unit Water Resources Management of São Paulo, grouped into 4 Vocational Units defined by Law 9,034 / 1994: Agriculture, Conservation, On Industrialization and Industrial. The significant reduction in the number of authorizations issued by CETESB between one period and another clearly indicates that with the substantial decrease in the occurrence of PPAs in of Top Hills, Mountains and Mountains Ranges, the demand for permits for interventions in this PPA was also significantly reduced. In this context, the amendment made by the new law has a potential negative impact on the conservation of natural resources due to the possibility of using and occupying these areas with activities such as agriculture, livestock, forestry, residential, commercial and industrial land subdivision, among others, among others, without any need for authorization, therefore without any control or restriction

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1246

FORESTRY AND ELEVATED LEVELS OF MERCURY IN AQUATIC ECOSYSTEMS: WHAT TO DO WHEN BEST MANAGEMENT PRACTICES ARE NOT GOOD ENOUGH?

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Forestry operations can increase the biomagnification of mercury in aquatic ecosystems. In Sweden, the concentrations of mercury in the biota exceed the European guidelines for Good Ecological Status in almost all lakes. The problem of high Hg concentrations in the biota, and the contribution of forestry to those high concentrations, is a problem shared by Sweden's Nordic neighbors Finland and Norway. The goal of the forestry-related Hg research has been to find ways to minimize the contribution of forestry operations to the bioaccumulation of mercury in the environment. The great variation of the effects which forestry operations have on Hg outputs, speciation and bioaccumulation holds some prospect that practical ways can be found to minimize the impact of forestry operations. But the magnitude by which Hg currently exceeds guidelines for safe consumption of fish and especially the exceedance of EU's criteria for good ecological status, means that society's goals with regards to mercury in the environment will not be met, even if forestry operations could be managed to make no contribution to Hg mobilization. This poster presents recent progress in defining the forestry sector's role in the problem of mercury in the Swedish environment based on extensive field studies as well as a structured dialog between the forestry sector and government regulators.

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1021

FIRE EXCLUSION INCREASES CANOPY INTERCEPTION LOSS IN LONGLEAF PINE (PINUS PALUSTRIS) FORESTS

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Evaporative loss from canopy interception (Ei) is an important component of the hydrologic budget in forested ecosystems, and numerous studies have demonstrated that forest structural characteristics, such as leaf area index and

stand density, affect Ei. The longleaf pine [Pinus palustris Mill. (Pinaceae)] ecosystem historically dominated much of the southeastern United States. This system is characterized by a relatively open canopy, low basal area, and sparse sub-canopy and is dependent upon frequent fire to maintain its structure. Excluding fire can result in a dense sub-canopy of woody species in just a few years. Our objective was to compare Ei in a longleaf pine forest under two different fire regimes to determine the effects of regular prescribed fire and fire suppression on Ei loss. We used climate stations and throughfall collectors to measure gross rainfall and estimate Ei at two sites, one mesic and one xeric. At each site, we collected throughfall weekly in stands representing two fire treatments: long-term frequent prescribed fire (2-year return interval) and 16 years of fire exclusion. Canopy interception was extremely variable at both sites, but cumulative Ei loss was consistently lower in the prescribed fire stands. Ei was highest in the xeric fire-exclusion stand, averaging ~11% of gross annual rainfall (128 mm/yr), whereas interception was lowest (~6% or 70 mm/yr) in the xeric prescribed fire stand. These results demonstrate that fire regime can have a substantial impact on forest hydrologic budgets and these findings improve our understanding of how fire regime affects specific components of ET in longleaf pine forests. This research has important implications for informing land management priorities in the southeastern U.S., particularly in light of recent regional policy disputes over both prescribed fire and water resources.

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1013

VARIABLE SOURCE AREA (VSA) DELINEATION AND VALIDATION IN SUB-TROPICAL FORESTED CATCHMENTS IN BRAZIL

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Native forest plays important role in regulation and provision of water, however, land-use change can modify the mechanism overland flow by soil saturation and affect original hydrological functions. The saturation overland flow occurs at Variable Source Area (VSA), which have high probability of saturation during a storm event, varying over time according to lateral flow and water table. Thereby, since VSA has different hydrological characteristics than other areas along hillslope gradient, its identification is essential to guide management practices and to preserve their ecosystem functions of regulation. The objective of this study was to compare VSA in two catchments with different type of forest. The catchment A is covered by native forest, and the catchment B is covered with forest plantation of Pinus spp. The VSA delimitation was done using a modified wetness index calculated from a high resolution Digital Elevation Model (1 m) processed in GIS, and the validation was made by data collected of soil water potential in a transect

along topographic gradient. The soil water potential was different along the transect and between the catchments. We found a threshold value of wetness index where soil remained saturated more than 50% of the time in the two catchments, contributing with runoff generation. In addition, in the catchment A the soil water potential was more variable over the time than catchment B. Beside difference on land-use, both catchments presented functioning of VSA. Therefore, the VSA method delimitation could be used in the planning and management forestry operations at catchment B, reducing risks of soil loss, stream contamination and modify streamflow regulation.

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1031

REVISIÓN ACERCA DEL EFECTO DE LAS PLANTACIONES FORESTALES EXÓTICAS DE RÁPIDO CRECIMIENTO SOBRE LA DISPONIBILIDAD HÍDRICA EN EL CENTRO-SUR DE CHILE

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Se presenta una revisión acerca de los efectos que generan las plantaciones exóticas de crecimiento rápido, Pinus radiata y Eucalyptus sp., sobre la disponibilidad hídrica en el centro-sur de Chile, a diferentes escalas espaciales y temporales. Se han recopilado estudios que tienen por lo menos un año de observaciones, tanto a escala de cuencas como de parcelas experimentales. Estudios de largo plazo en grandes cuencas localizadas en la zona mediterránea de Chile enfocados en el cambio de cobertura de bosque nativo hacia plantaciones forestales, muestran una reducción sostenida del rendimiento hídrico, especialmente en la época de verano. Los estudios de balance hídrico en pequeñas cuencas indican que las plantaciones maduras de Eucalyptus sp. provocan efectos mayores que las plantaciones de Pinus radiata, ya que sus tasas de evapotranspiración son mayores y el rendimiento hídrico menor, mientras que las plantaciones jóvenes no presentan diferencias en el balance hídrico. Esta sistematización tiene como objetivo poder contribuir a la discusión y debate acerca de los impactos ambientales que generan las plantaciones forestales de rápido crecimiento, en este caso enfocado en sus efectos sobre la disponibilidad de agua. Esta información debiese contribuir a mejorar la toma de decisiones y el diseño de políticas públicas acerca del mejor uso y ordenamiento del territorio nacional.

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1110
Water-related ecosystem services in landscapes with several coverage conditions of forested-savanna

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Forest landscapes ecosystem services play an essential role to human survival, but are affected by anthropic activities, especially water-related ecosystem services (ESw). We need to clearly determine up to what extent the conversion of forests by anthropic activities can cause irreparable losses to the availability of ESw. This requires the adoption of a model that allows comparing landscapes under different conditions of human use and forest conservation, by assigning values. We present a model that reveals the dependence between forest, pasture and ESw quantities in Brazilian forested-savannas. Data from ten catchments were obtained for electrical conductivity, pH, temperature, total dissolved and suspended solids, dissolved oxygen, turbidity, total phosphorus, nitrate, nitrite, ammonia, and total and fecal coliforms, which were hierarchized by Random Forest algorithm and compiled in indexes. The results allowed indicating that the best potential gains of ESw occurred by maintaining at least 70% of forest cover.

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1040
Woodland's degradation and its effect on soil profile water dynamics in highlands of central Argentina

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Rivers that provide water to over two million people are born in the highlands of central Argentina. Human-induced disturbances by livestock and fire regimes, shape the vegetation-soil complex which distributes in patches within this granitic outcropping landscape. Given the relevance of these headwater catchments in water provisioning services, there is a need of determining the impact of these disturbances on the soil profile water dynamics. For this, we selected sites with contrasting vegetation structure (woodlands, tussock grassland, fernland and grazing lawn) as a result of the named disturbances, though similar topography. We

measured through a hydrologic year precipitation inputs (rain and fog) and water content through the soil profile. Our main results showed that, while vegetation structure is more complex, more fog is intercepted regulating top soil water dynamics, as well as more water is stored at the soil profile. Woodland and tussock grassland, had the higher rainfall response rate; while the most degraded physiognomy (grazing lawn) dried quicker than other physiognomies as a response to the absence of rain. Woodland exhibited the tightest association between superficial water content and water content at the deeper layer of successive days prior to the superficial one, suggesting high hydraulic conductivity. Altogether, our results suggest that woodlands capture, infiltrate and store more stable water. Thus, human-induced disturbances menace this valuable ecosystem service in headwater catchments of central Argentina.

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954

CHARACTERIZATION AND ABUNDANCE OF DIATOMS IN FOREST WATERSHEDS TO EVALUATE THE EFFECT OF FOREST MANAGEMENT

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conductivity, soluble phosphorus, ammonium, nitrate, and transmitted light total were measured to represent different forest management schemes. Algae genera composition was strongly correlated with transmitted light total, conductivity, nitrate, phosphorus and ammonium. That play a role in controlling algal community (abundance and richness) through both bottom-up and top-down control. The most common genera across all sites were Gomphonema, followed by Fragilaria and Navicula. The genera's main associations were of presence of sediments, high conductivity, and presence of nitrates or waters slightly contaminated from oligotrophic to mesotrophic water. These findings suggest that forested watersheds with plantation above 70% of watershed area it is especially important that strategies are enacted to reduce potential damage to aquatic ecosystems, including application of discontinuous forestry and harvesting forest. Such continuous pressure for forest management is unlikely to abate, making it increasingly important to understand how intensive management practices like headwater watersheds, if improperly managed, interact with stressors to change and modify forested headwater ecosystems. We acknowledge the interest and support of Forestal Mininco S.A. in the development of this research. KEYWORDS: Algal community; Forest management; Non-metric multidimensional scaling (NMDS)

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1134

A preliminary study of the ecosystem health of Lake Pullinque and threats of surrounding area

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Chilean water resources have suffered considerable alterations as a result of the anthropogenic intervention, an example of which is the alterations at scale of hydrographic basins in southern Chile on Araucanian lakes where an acceleration in eutrophication processes has been observed, mainly due to nutrient inputs. In view of the above, objective of this study was to determine the summer health status of Lake Pullinque, located in Los Ríos Region, by means of evaluation of physical, chemical and biological parameters and their relationship with possible surrounding anthropogenic threats. Water samples were taken for physicochemical analysis, phytoplankton, zooplankton, benthic macroinvertebrates, and fish. A cartographic analysis of vegetation was carried out and it was analyzed what kind of industrial activities could behave as a threat. Two copepods, six families of macroinvertebrates, four fish species and, six phytoplankton groups were identified with a total of 1.19 x 106 cel/L. Analysis of the vegetation revealed that most of area

is surrounded by pastures and agricultural areas and that there is a hydroelectric power central, which has a direct influence on lake. Although physical-chemical parameters were within normal limits, chlorophyll'a' was high for an oligotrophic lake, indicating an increase in primary productivity, perhaps due to increased nutrient inputs from surrounding areas. It can be concluded that species richness, water physical-chemical parameters, and anthropogenic activities are a key factor in assessing the health status of a system, but seasonal studies should be conducted to determine with certainty whether aquatic system is being affected by external activities or is a natural condition of the system.

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1175

HYDRO-ENVIRONMENTAL DIAGNOSIS OF THE CONSERVATION OF THE SPRINGS, ITANGUÁ CATCHMENT, BRAZIL

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UFSCar

Industrial development, the steady growth of population and agricultural activities, raise concerns about the degradation of rivers and water quality. To ensure their integrity, rivers and springs must be properly insulated to avoid any negative and impact-inducing intervention. Given this, monitoring and evaluation of river ecosystems is extremely necessary, since the data collected are necessary for future decision-making regarding the recovery of these ecosystems. The objective of this work was to evaluate the environmental quality of the springs of the stream Itanguá, Sorocaba-SP, Brazil, by means of a rapid evaluation protocol, adapted for the monitoring of springs, whose data were collected between June and December 2015. The results showed changes in their natural characteristics, in most of springs due to human interventions, and the nascent of the urbanized area were those that presented the worst environmental conditions. The predominant changes are related to non-planning of land use, urban expansion, suppression of riparian forests, erosion processes and siltation.

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1176

THE PROTECTION OF SPRINGS IN CONSOLIDATED URBAN AREAS: CASE STUDY IN BRAZIL

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The territory of the city of Sorocaba,SP, Brazil is marked by a dense water courses, and one of the sub-basins that make up the main water courses is Ribeirão do Lajeado, also known as Água Vermelha, affluent from the left bank of the river Sorocaba placed in a consolidated urban area. The present paper has generated an Environmental Impact Index in Ribeirão do Lajeado's Water Springs, Sorocaba, Brazil. For this purpose, it has been performed on the field a macroscope diagnosis of the water springs, being that every evaluated parameter received a grade (from 1 to 3) for its later classification. On this evaluation, the following parameters have been verified: color, odor, existence of garbage on the banks, existence of floating materials, foam, oil, sanitary sewer, state of vegetation, human presence and animal presence in the Permanent Preservation Area, protection of the area and proximity to residence or establishments. The results showed that all the visited places are impacted by the urbanization, being the strongest indicative for that, the amount of garbage found on those places. Color, smell, foam, floating materials and oil, in general, were positively highlighted, but sewer and human presence had recurrent negative results. The most alarming verified parameters are related to the water springs proximity to establishments, nonexistent protection of the area, the Permanent Preservation Area that does not meet the 50 meters laid out in law nº 12.651/12 of the Forestry Code. The generated Environmental Impact index has classified the water springs as "reasonable". "bad" or "terrible", without getting any classification "great" or "good" propitiating a debate around the water resources conservation subject and if they are important in the context of urban basins, besides instigating deeper researches in the Ribeirão do Lajeado sub-basin to indicate its integrity and promote conservation actions of the springs.

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1136
Riparian forest restoration in Macacu river with prisoners workforce

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This paper aims to present the project for restoration of the riparian forest of Macacu river, showing some of its characteristics and results. The restoration took place in riparian areas of the medium Macacu river watershed. The planting areas where chosen in a common agreement with local land owners. For each planting site it was done a preliminary survey of the area conditions. An executive project was

elaborated addressing the existing vegetation, soil characteristics (fertility analysis and physical description), fertilization recommendation, leaf cutter ant control, weed control, indicated species, planting spacing and arrangement, recommendations on planting and maintenance (replanting, weeding, cover fertilization, etc) necessity of fencing and opening of firebreaks. The workforce for field activities was composed by prisoners that were participating in the "Replantando Vidas", a socio-environmental program of the Water and Sewage State Company of Rio de Janeiro (CEDAE), with this program, CEDAE promotes the resocialization of inmates of the state prison system. The prisoners received professional training, national minimum wage, meal and transportation allowance and remission of one day of imprisonment for every three days worked. As results of the Macacu project, 47 different areas were reforested, with the participation of 42 local land owners, totaling 47 hectares of riparian forest restoration. There were also 26 areas, which summed for 17 hectares, where the project provided inputs, such as seedlings, fertilizer and technical support, for land owners who preferred to do the planting for their own, because they did not want prisoners working in their properties. The project contributed in increasing the riparian forest cover in the margins of the Macacu river, helping in the environmental compliance of local rural properties, promoting social inclusion of prisoners and inserting into the local community the theme of riparian forest restoration.

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1106

Measurements of surface water flow in restored springs at the Mantiqueira mountains in Extrema, MG/Brasil

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Spring restoration is supposed to improve surface water quality as asserted by the brazillian federal conservation program Produtor de Águas/National Waters Agency, and specially the local Conservador das Águas Program in Extrema, MG (CAP). Restoration with native forest vegetation is also supposed to potentially improve soil conditions that helps to promote higher water infiltration and eventually lead to higher transient soil storage, aquifer recharge and minimum surface water flow. The question rises with lack of measurements to observe these mechanisms and the range of time necessary to establish such connections, the uncertainties associated to the limitations imposed by the soil and aquifer types, and several other limitations. We show a scientific research work designed to help understanding the

hydrological patterns in a set of restored springs at the Posses river basin at CAP. Surface flow at springs was measured on a monthly basis using direct manual water collection, from Jan 2015 to March 2018, at 40 springs to date that were individually associated to areas of upstream water contribution varying roughly between 0,5 to 50 ha. Preliminary results showed significant seasonal variability with the maximum flow in the rainy season concurrent with the seasonal rainfall (demonstrated by Principal component analysis). We noted the impact of the regional drought (Out 2013/Jan 2015) extending in the spring flows thru late 2015, when the peak flows increased again from 2016 on. We found evidence of at least two significant different samples of springs, based on the mean and the annual amplitude. The investigation is planned to pursue explaining the spatial variability of the flow regimes based on physiographic factors (relief, vegetation, soil, water table depth and recharge area upstream). This work was designed and has been developed with the Project Climate-Smart Watershed Investments in the Montane Tropics of South America, financed by FAPESP/Belmont Forum and supervised at IAG/USP.

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1238

Restauración, protección y conservación de la micro cuenca productora de agua de la comuna de Corral, región de Los Ríos Chile

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En un esfuerzo conjunto entre la comunidad, el sector público y la empresa privada, en el año 2013 se firmó un convenio para poner en marcha un programa largo plazo que tiene como objetivo general "Asegurar el abastecimiento continuo de agua, tanto en cantidad como en calidad de la micro cuenca inserta en el predio El Boldo". Los firmantes fueron en representación de la comunidad la Ilustre Municipalidad de Corral, por el sector público la Corporación Nacional Forestal y la Empresa de Servicios Sanitarios de Los Lagos (ESSAL S.A.).El predio El Boldo tiene un superficie de 186,7 hectáreas, de las cuales 45,5 hectáreas fueron reforestada con especies nativas, 38,8 hectáreas están compuestas de plantaciones exóticas, otras 8,3 hectáreas por matorrales y la restante bosque nativo en distintos estados de alteración antrópica. Los objetivos específicos se pueden resumir en tres grandes líneas de trabajo; la restauración tanto activa como pasiva y sus labores culturales posteriores, que al término de las operaciones forestales planificadas reduzcan los aportes de sedimentos a los causes a través de la generación de una cubierta permanente que ayude asegurar la calidad del agua. La disponibilidad de agua se espera mejorar a través del reemplazo de plantaciones de eucalipto por bosque nativo y cuando éste allá alcanzo su equilibrio. La protección y conservación del área para controlar amenazas como la tala ilegal y el ramoneo por animales

domésticos y la extensión y difusión del proyecto, para otorgarle pertinencia y que la comunidad lo sienta como suyo. Trascurrido cuatro años de actividades se tiene los siguientes resultados de corto plazo, la restauración de 45,5 hectáreas con especies nativas del tipo forestal Siempreverde ,lo que representa un total de 135.000 plantas (donde la especie principal es Coigue acompañado de Canelo y varias mirtáceas),la construcción de 6.700 metros de cerco perimetral para controlar amenazas referidas principalmente al daño por ramoneo de animales domésticos y sustracción de leña que afecta a la masa boscosa y por último no menos importante las actividades de extensión y difusión del proyecto, ejecutándose visitas guiadas con alumnos de las brigadas ecológicas , organizaciones vecinales y directivos de los APR (Agua Potable Rural),quedan muchos desafíos de mediano y largo plazo por realizar.

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1173
INDICATORS OF FOREST RESTORATION: A CONTRIBUTION FROM THE SOIL STRUCTURE

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The growing need to get the conservation and/or restoration of natural attributes of ecosystems, the restoration of the undetermined is related to the difficult task of rebuilding the forest seeking the restoration of biodiversity, structure and ecological relations of the community and complex of the physical environment as well as the important role played by forest in the receipt and distribution of rain water in order to make it available to the soil. The purpose of this study is to characterize the behavior of hydrological indicators in forest areas at different stages of restoration for natural regeneration in private reserve of Natural patrimony "Forest Perennial Waters", Brotas-SP. hydrological parameters measurements were performed and vegetation structure in three treatments, totaling nine repetitions in each. 1 treatment presented major averages, for resistance to penetration of the soil and soil moisture (0.5 MP e 74%), the treatment 2 showed a greater infiltration of the soil (174, 3 mm.h-1), but not treatments differed among themselves, meaning land covered guarantees the quality of your physical characteristics. To the structural parameters of the vegetation, the 3 other differentiating treatment for basal area, density and maximum diameter, showing that the regeneration areas still not developed significantly. I concluded that even with the regeneration areas in developing initial hydrological indicators featured and the vegetation structural must be correlated positively to a satisfactory development of the restoration of degraded areas.

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1234

MEDIUM AND LARGE-SIZE MAMMALS IN REGENERATION AREA IN SAVANA, BRAZIL

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The Brazilian Savana it was priority hotspot to conservation on State of São Paulo occupying actually 1% of the state territory. On 2008 the BIOTA program indicate priority areas to connectivity increment and conservation on state territory, was be some of them distributed on State of São Paulo Savana. On the knowledge context it was perform a study to identify the large and medium mammals present on Reserva Particular de Patrimônio Natural (RPPN) Floresta das Águas Perenes, that was found on the some of the indicate areas to connectivity increment and conservation for the BIOTA program and considered as High Conservation Value Forest by the Forest Stewarship Council (FSC) for the hydrographic basin protection, was be the RPPN on Brotas city limits. The samples occurrence during 10 rest days, ridding three transects of 2 kilometers each
on dirty roads in search of traces and with a 5 cameras trap distributed on transect 2. It was found 24 species of mammals, was be the species distributed on 7 orders and 12 families, the most frequent were Chrysocyon brachyurus, Puma concolor, Mazama gouazoubira e Cerdocyon thous, still counting with 6 classified in dangerous species by the Portaria No 444, de 17 de dezembro de 2014 and 3 exotic species (Sus scrofa, Lepus europaeus e Canis familiares). On study occurrence it was identified points of wild life crossing on dirty roads that will be possible verify critical points of wild life trampling. The work conclude that the RPPN has a varied diversity of large and medium mammals, presenting important species to conservation as well occurrence of exotic species that will be harm the native species, as well necessity to take actions of conservation and management propose on this work.

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1665

PROPUESTA DE UN ÍNDICE DE VULNERABILIDAD SOCIAL ANTE PÉRDIDA DE SERVICIO ECOSISTÉMICO APROVISIONAMIENTO DE AGUA: CASO DE ESTUDIO PARA UN SECTOR RURAL UBICADO EN LAGO RANCO, REGIÓN DE LOS RIOS, CHILE.

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En muchos sectores rurales de la zona centro sur de Chile existen Comités de Agua encargados del suministro de agua potable para consumo humano. En el sector denominado Tringlo A, comuna de Lago Ranco (Región de Los Ríos, Chile), se han presentado situaciones de escasez de agua vinculadas con los procesos de transformación del suelo. Consecuente con esto, el Instituto Forestal de Chile, priorizó una cuenca para iniciar acciones de Restauración de bosques nativos, con el fin de mantener la regulación hídrica y garantizar la provisión del servicio ecosistémico (SE). Con el fin de contribuir al desarrollo de la estrategia de restauración, en este trabajo se estableció la percepción del riesgo de las comunidades frente al deterioro y/o pérdida de SEs aprovisionamiento de agua y regulación hídrica y las posibles amenazas que inciden en la escasez del recurso en el sector. A través de técnicas participativas se propuso un índice de vulnerabilidad social (VS) frente a este cambio. En general, los habitantes perciben que el aumento de población en el sector, las condiciones de cambio climático y malas prácticas de uso de agua, son las principales causas a la escasez de agua; adicionalmente, el indicador de VS mostró que el 57% de los usuarios entrevistados poseen una alta vulnerabilidad ante la pérdida o deterioro del SE provisión de agua y un 43% una vulnerabilidad media. Esta información asociada a la vulnerabilidad y la percepción del riesgo, tienen la potencialidad de soportar, focalizar y priorizar los esfuerzos de restauración a escala local.

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984

Blue Targeting Tool: a simple forestry planning for riparian buffer zones adapted to Brazilian streams

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The riparian zone is essential for the delivery of key ecosystem services, such as the buffering of flood waters, maintenance of water flow during dry periods, and

provision of water quality through natural filtration and treatment. The Blue Targeting Tool (BTT) was developed by WWF Sweden and forest owner associations, to assist forestry planning along small rivers. The BTT is actively used by Swedish forest owners for designing riparian zones. The strength of the BTT is its simplicity, it can be used by non-technical stakeholders. The protocol includes the assessment of CISA: C - conservation value, I - impact, S - soil sensitivity and A - added value. The scores of the CISA survey are then used to rank the stream section into one of four "Blue Target classes". For each class there are recommendations on appropriate riparian zone management that will sustain healthy riparian ecosystems, including water quality, regardless of legislation. Within the context of the EU Interregproject WAMBAF (Water Management in Baltic Forests) and the FAO Forest and Water Framework, the BTT is being adapted for other systems, such as tropical forest ecosystems in Brazil. To achieve this, the tool needs appropriate parameters according to the characteristics of Brazilian streams. Therefore, two versions of the protocol, for high-gradient and for low-gradient streams, were proposed. This work is under progress and the Brazilian version of BTT need to be tested in the field. The main challenges in creating and applying the tool in tropical systems is characterized by high natural environmental heterogeneity. Another challenge is to adapt a protocol designed for temperate streams to tropical streams, which differs in hydrological and climatic dynamics that, as a consequence, changes structural characteristics of streams. Possibilities for the BTT to assist in the management planning of tropical riparian forests worldwide will be highlighted.

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994

Eucalyptus forest plantation management: effects on water quality and export of nutrients and suspended solids

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Forest management operations have the potential to alter the concentration of water quality parameters in catchments covered by planted forests. Although the effects of forest management have been widely studied in temperate countries, few studies are developed in tropical climate, especially in forest plantations with intensive management, as it is the case of most Eucalyptus plantations in Brazil. Intensive management is characterized by fast-growing forests, short rotation cycles and high productivity, which require application of fertilizers. Eucalyptus is the most common planted forest type in Brazil and the State of São Paulo has the second largest planted area in the country. In this study we assessed the effects of management of Eucalyptus forest plantations on concentration and export of

nutrients and suspended solids at four catchments. Results showed that timber harvesting and subsequent forest management operations do not alter most of the annual median concentration of nitrate, potassium, calcium and magnesium. Annual concentration of suspended solids increased during the first year after timber harvesting (DC1) in all studied catchments, however only two catchments this increase was significant. In the fourth year after timber harvesting (DC4) most annual concentrations of nutrients decreased in relation to DC1, including suspended solids which decreased significantly in all catchments. In the first year after harvest, an increase in annual discharge/precipitation ration occurred in three watersheds, which also increased export values of nutrients and suspended solids. In the fourth year after timber harvesting, discharge/precipitation ratio values decreased, as did exports. Based on American and Brazilian standards for water quality for human consumption and the values reported in literature, management of fast-growing Eucalyptus forest plantations does not compromise water quality, particularly regarding concentration and export of nitrate and suspended solids. However, it is noteworthy to mention that there are still no acceptable alteration values for catchment health.

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1210

Strong influence of the ocean in the relic forest on semi-arid area of northern Chile; the case Talinay, Fray Jorge National Park

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Semi-Arid North-Central Chile is particularly sensitive to extreme variability in the global hydrological cycle, with severe droughts affecting the area in the last decades so ecosystem within this location are more vulnerable . This is the case of evergreen forest located in Talinay (Fray Jorge National Park), with great (paleo) ecological importance since represents a relict forest segregated for climate change since the Pleistocene. Multi-isotope , hidrogeochemistry and nutrients analysis of coastal fog were made with an integrative perspective to unfold the amount of marine influence in quantitative terms . We developed a simple mix model to identified percentages of fog and rain in the water that is sustaining the

forest and identified a seasonal and altitudinal patron. In addition, W-E changes in this amount, with much higher values in the west side of hill and in spring (~90% fog) that decreased until almost 15% at highest altitudes and in winter, where rain is a more important resource than expected. Also, we identified higher nutrients values in fog than in rain, but despite this, our results don't show that this nutrients are been used for the forest. Isotopic and mayor ionic analysis in groundwater demonstrate that fog is not playing a role in aquifer recharge but is imprinting a signal in ionic values of the groundwate.

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1077

Caracterización de una plantación forestal de especies nativas de la Universidad Nacional de Asunción, Paraguay

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En áreas urbanas, las plantaciones forestales pueden llegar a mitigar los impactos generados por los eventos meteorológicos previniendo inundaciones por el colapso de infraestructuras. Estas plantaciones representan los filtros naturales de aire debido a que éstas, reducen los contaminantes de la atmósfera generados por la acción del hombre como la emisión de gases, polvo y otros componentes sólidos volátiles como CO2, NOX, etc. Este trabajo tiene como objetivo general la caracterización de una plantación forestal de especies forestales nativas de la Universidad Nacional de Asunción. Esta investigación se llevó a cabo en el Campo Experimental Forestal de la Facultad de Ciencias Agrarias de la Universidad Nacional de Asunción, San Lorenzo, Paraguay, ubicado entre las coordenadas 25° 21' latitud sur y 57° 27' longitud oeste. Se realizó un inventario forestal considerando todos los individuos, árboles y palmas, con DAP igual o mayor a 10 cm, siendo las variables estudiadas: composición florística, abundancia de especies, área basal, volumen de fuste, biomasa aérea, radicular y total aplicando las ecuaciones recomendadas por el IPCC (2006). Con base a los resultados obtenidos se reportaron 6 familias, 10 géneros, 11 especies y 143 individuos en una superficie de 3.250 m2 (0,325 ha), lo que equivale a 440 individuos/ha. Las familias más representativas corresponden a la Fabaceae y Bignonaceae. El promedio total del área basal fue de 29,7 m2/ha, el volumen de fuste promedio arrojado fue de 369,56 m3/ha, alcanzando una biomasa aérea total promedio de 914,22 t/ha; biomasa radicular fue de 20,85 t/ha y la biomasa total promedio de 978,37 t/ha con la aplicación de las metodologías propuestas de IPCC (2006). En conclusión, con este

estudio se logró determinar la composición florística, las variables dasométricas así como también la biomasa de la plantación en estudio.

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1081

CARACTERIZACION FLORISTICA EN EL BOSQUE DE GALERÍA DE LA UNIVERSIDAD NACIONAL DE ASUNCIÓN, PARAGUAY

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Los bosques de galería son ecosistemas estratégicos para la humanidad por ser corredores biológicos y de flujo genético que conectan pequeñas zonas. Estos son de gran importancia pues albergan numerosa flora y fauna silvestre y desempeñan funciones de sustento y hábitat para una gran cantidad de animales. El objetivo general de este trabajo fue caracterizar la flora en el bosque de galería, ubicado en el Campus de Facultad de Ciencias Agrarias, San Lorenzo, Paraguay. El trabajo experimental se llevó a cabo en el Campus, dentro del bosque de galería que se encuentra situado en microcuenca del arroyo San Lorenzo. El relevamiento de datos a campo para la caracterización del bosque se llevó a cabo en 4 parcelas de muestreo. En cada parcela se midieron todos árboles con DAP≥ 10 cm y se registró la presencia de especies herbáceas y se realizó la descripción de la estructura horizontal del bosque en estudio. Se pudo observar 12 familias, 10 de las cuales fueron forestales, 1 herbácea y 1 briófitas; estas dos últimas mencionadas en una gran cantidad cubriendo todo el soto bosque, totalizando así 159 individuos con 18 géneros (533 individuos/ha). La familia más representativa fue la Meliaceae con 4 especies, seguidamente con las familias Myrtaceae con 3 especies, Fabaceae con 2 especie y las restantes con 1 sola especie. La especie más abundante es la Trichilia catigua, seguida por Inga uraguensis y la menos abundantes son Allophylus edulis y Psidium guajava. La especie dominante es Cabralea cangerana. Las especies más frecuentes son la Cabralea cangerana, Cecropia pachystachya, Inga uraguensis, Syzygium cumini. La especie de mayor peso ecológico es la Cabralea cangerana. En conclusión, se logró identificar las especies arbóreas, arbustivas y herbáceas presentes y determinar la estructura horizontal del bosque de galería de la Universidad Nacional de Asunción.

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1365

The value of citizen science in freshwater research: An example from agricultural small streams in the Colombian Andes

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Partnerships between people, municipalities, schools, and universities offer a great opportunity to implement citizen-based programs focused on conservation or restoration monitoring of freshwater ecosystems, especially in montane agriculture-dominated areas. An important issue consists in the promotion of native riparian vegetation -from microcatchments to river network systems-, as a habitat for natural enemies and arthropod biodiversity conservation, which could increase their abundance and fitness, being especially useful in highly simplified areas or monocultures such as typical agricultural riverscapes of the Colombian Andes. As part of a monitoring study on traditional and new techniques for evaluating water quality using terrestrial and aquatic insects inhabiting microcatchments under contrasting anthropogenic pressures (agriculture, livestock, gold mining) in central Colombia (Chinchiná river basin), we selected three agriculture-small streams and a reference (forested) stream. The main objective was to propose a socio-environmental framework focusing about the importance of rural people in the knowledge, management and conservation of riverine, riparian and agricultural arthropods; all immersed in heterogeneous landscapes. Our study highlights the necessity of integrating citizen science programs on both freshwater quality, quantity and the surrounding biodiversity of agriculture-dominated streams despite a scarce participation and companion of academia, government and local, regional and/or national environmental authorities. Conservation strategies involving the establishment of native riparian plants around horticultural systems in montane areas could be an effective way to reduce pest populations mediated by natural enemies growing on this riparian vegetation. Finally, citizen and rural science are changing, and a deeper understanding of arthropod community responses to agriculture intensification in mountainous microcatchments will facilitate their restoration.

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23765

EXPERIENCIA PILOTO PARA LA PRIORIZACIÓN Y GENERACIÓN DE PROPUESTAS DE RESTAURACIÓN DE BOSQUE NATIVO EN CUENCAS PROVEEDORAS DE AGUA EN LAGO RANCO, REGIÓN DE LOS RÍOS.

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Este trabajo presenta propuestas para la restauración de bosques nativos y otros ecosistemas degradados en una cuenca proveedora de agua en la Región de los Ríos, Chile. Esta experiencia piloto se enmarcó en el proyecto de "Forestación Sustentable y Manejo Integrado de Cuencas", que ejecuta la Corporación Nacional Forestal (CONAF) en la Provincia del Ranco. Se realizó un análisis de priorización de áreas para restaurar utilizando un enfoque de oferta y demanda de agua, considerando como unidades básicas de análisis las cuencas proveedoras de agua y la cobertura de bosque nativo. Como resultado se seleccionó una cuenca de 12 ha y que abastece a 150 familias. Las propuestas de restauración fueron diseñadas desde la definición de componentes y valores propuesta por la aproximación conceptual de la restauración ecológica, caracterizando relaciones sociales y atributos biofísicos de la cuenca y área de influencia. El análisis biofísico mostró degradación del bosque nativo, presencia de matorrales, como fase posterior a la tala de los bosques. Se identificaron las principales amenazas para la restauración: regeneración natural de especies exóticas invasoras, corta ilegal de árboles y presión de uso por ganadería. Las propuestas incorporan acciones silvícolas como la tala de especies arbóreas exóticas en la cuenca, reforestación con especies nativas, habilitación de terrenos para la regeneración natural, cercado de estas áreas, manejo de los matorrales de Maqui (Aristotelia chilensis) para mejor producción de frutos y la habilitación de praderas para uso agropecuario, entre otras. Para el éxito de la restauración, se propone el involucramiento de la comunidad en acciones de monitoreo y control, convenios del CAPR con propietarios de tierra y ganado, y el involucramiento de la Municipalidad de Lago Ranco como actor central en la elaboración de convenios y resolución de conflictos.

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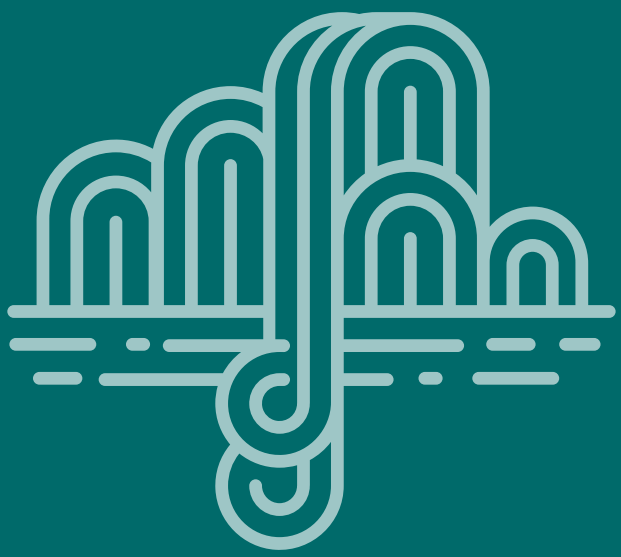

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