# Ecosystem Services

## *CR2*

## Taller 8 y 9 de Abril

**Antonio Lara, Christian Little**
**& Mauro González**
**November 7, 2012**

# Outline

- Team
- Background
- Objectives
- Tasks

# Team:

## Researchers

- Antonio Lara,  Mauro González
- Mario Pino,  Carlos Jara

## Post Doc:

- Christian Little

## Research Assistant:

Rodrigo Bravo

## Students:

Ph.D. Mario Romero, Marco Cortés, Rocío Urrutia

M.Sc. Pilar Fierro, Romina Novoa, Mauricio Montiel

# Coastal Sector in Maule Region (0.5 million ha)

1975

1990

2000

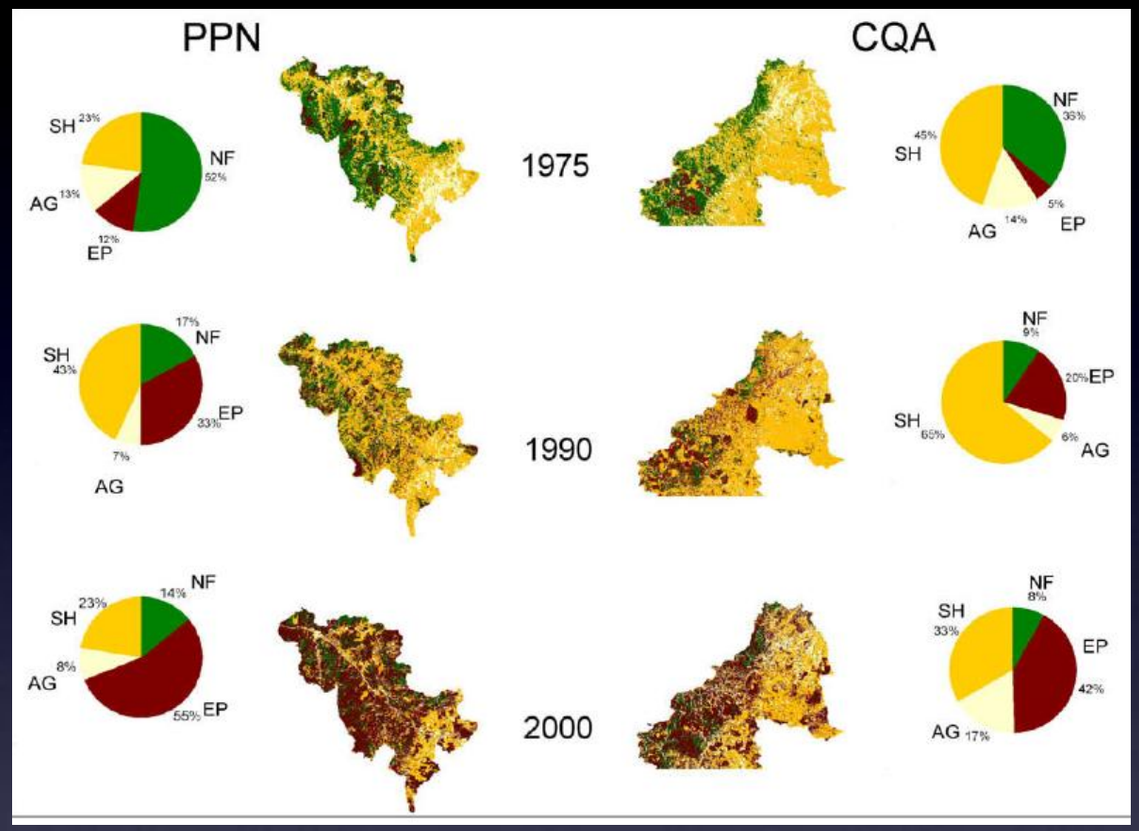
2007

- shrubland
- native forest
- agriculture
- plantations

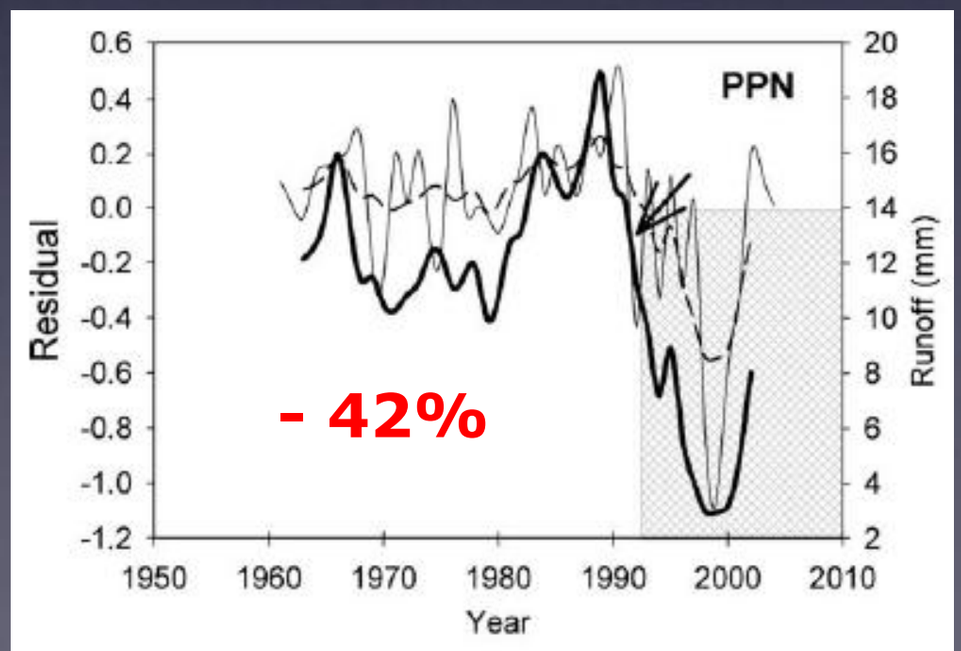
From: Echeverría et al., 2006

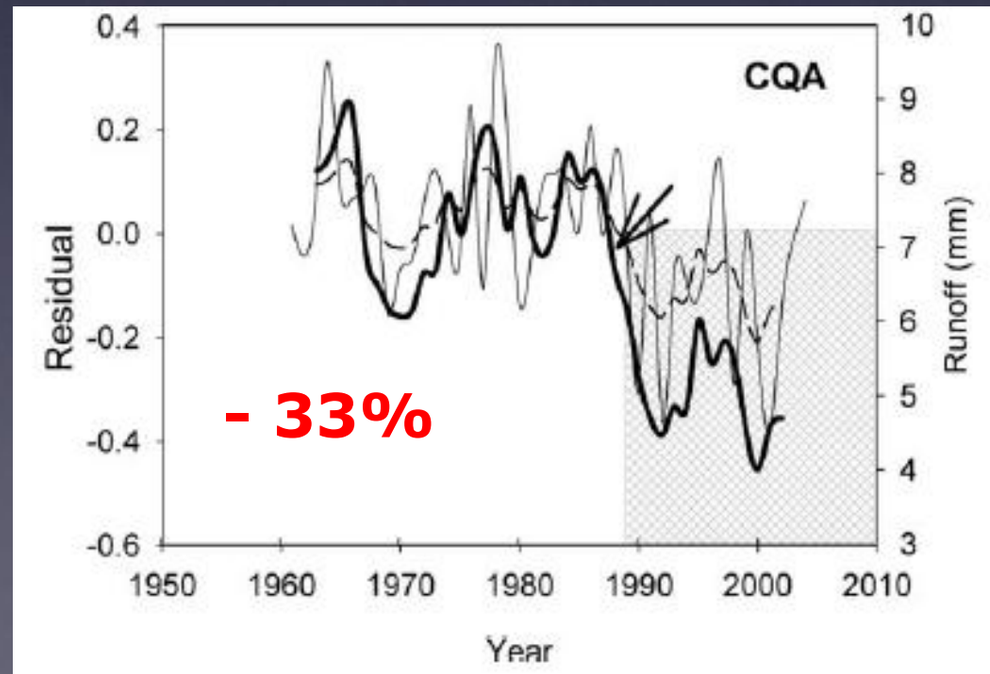
# Effect of forest cover on runoff in large watersheds (PPN: 26.000 ha and CQA: 70.000 ha)

C. Little et al. / Journal of Hydrology 374 (2009) 162–170




Q/P residuals and total summer (Dec-Mar) runoff predicted by an equation developed from the observed data



# Ecological restoration for the recovery of water yield as an ecosystem service (2006 -

MASISA

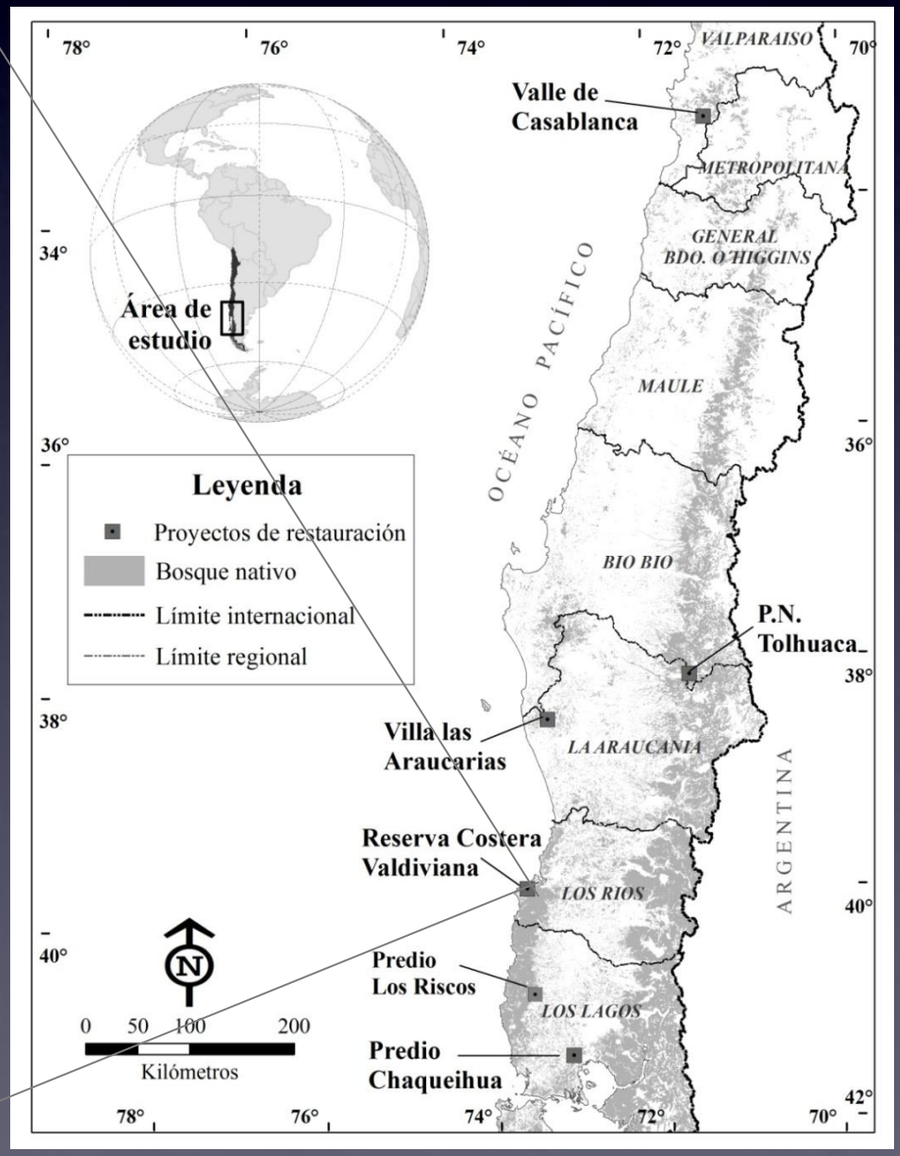
LIBERTAS CAPITUR
UNIVERSIDAD AUSTRAL DE CHILE

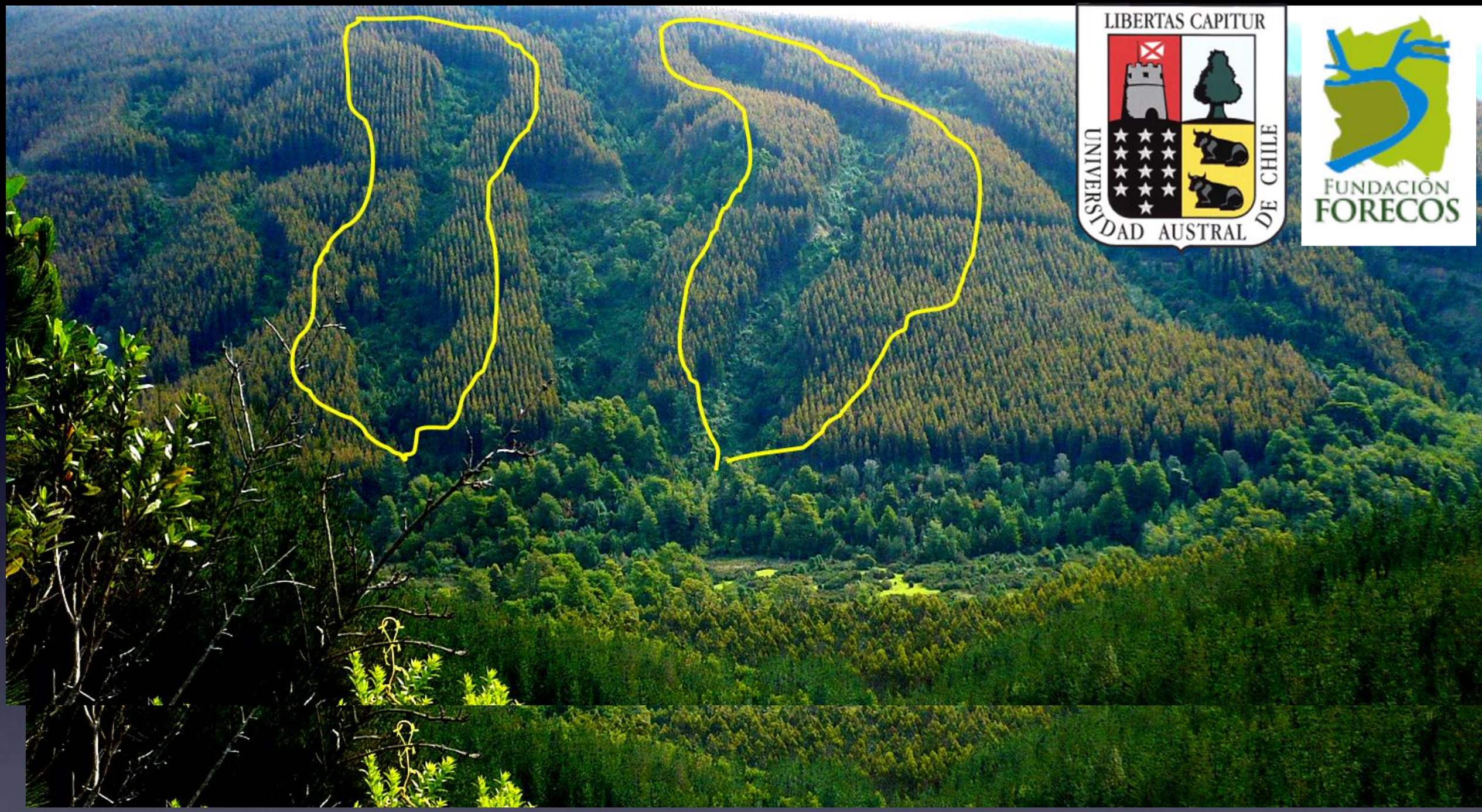
The Nature Conservancy

Technical cooperation agreement

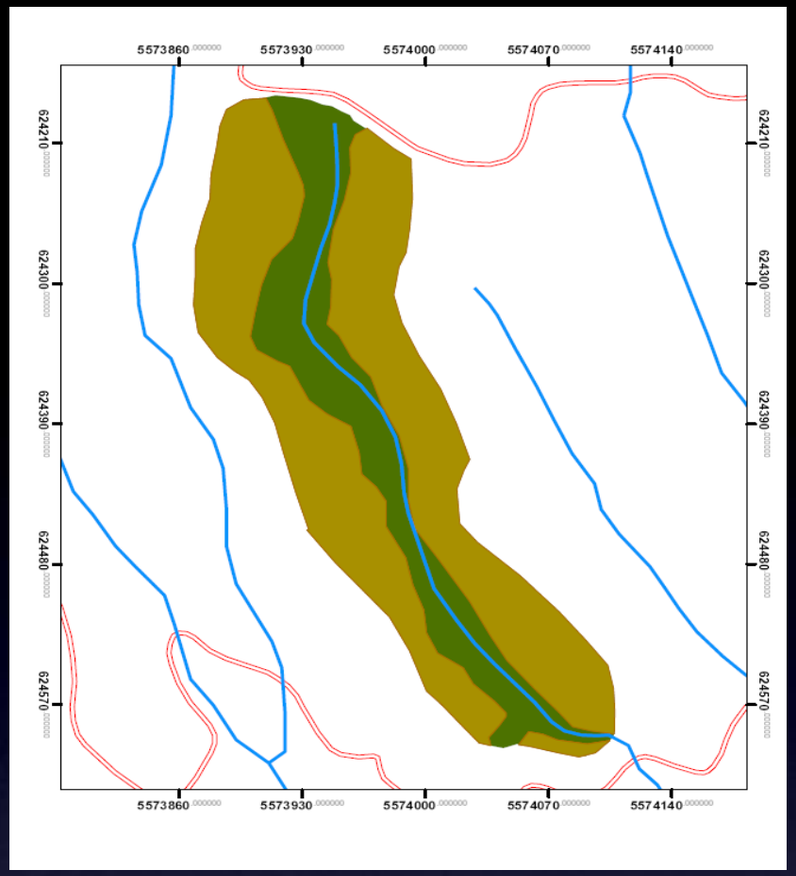
# Study Area

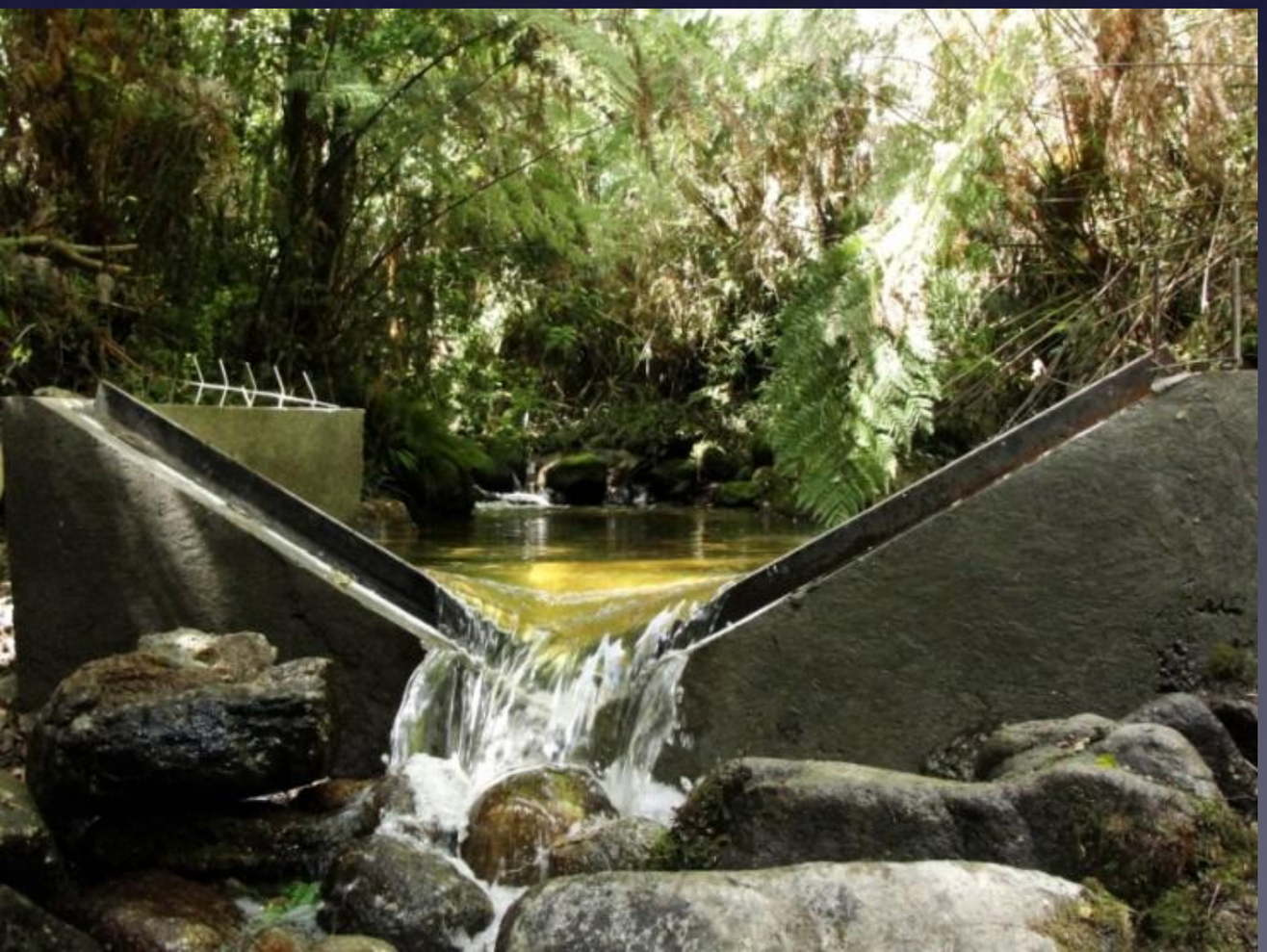
Océano
Pacífico
South America
Área de Estudio
Bosques Templados
VALDIVIA
Niebla
Corral
Huape
Tres
Chaihuín
Huiro
Punta Galera
40º
Río Futa
Río Colún
Río Chaihuín
Colún
Hueicolla
Río Hueicolla
El Peligro
Río Bueno
LEYENDA
Proyecto de Restauración
Plantaciones de Eucaliptus
Parque Nacional Alerce Costero
Reserva Costera Valdiviana
Ciudades
Hidrología

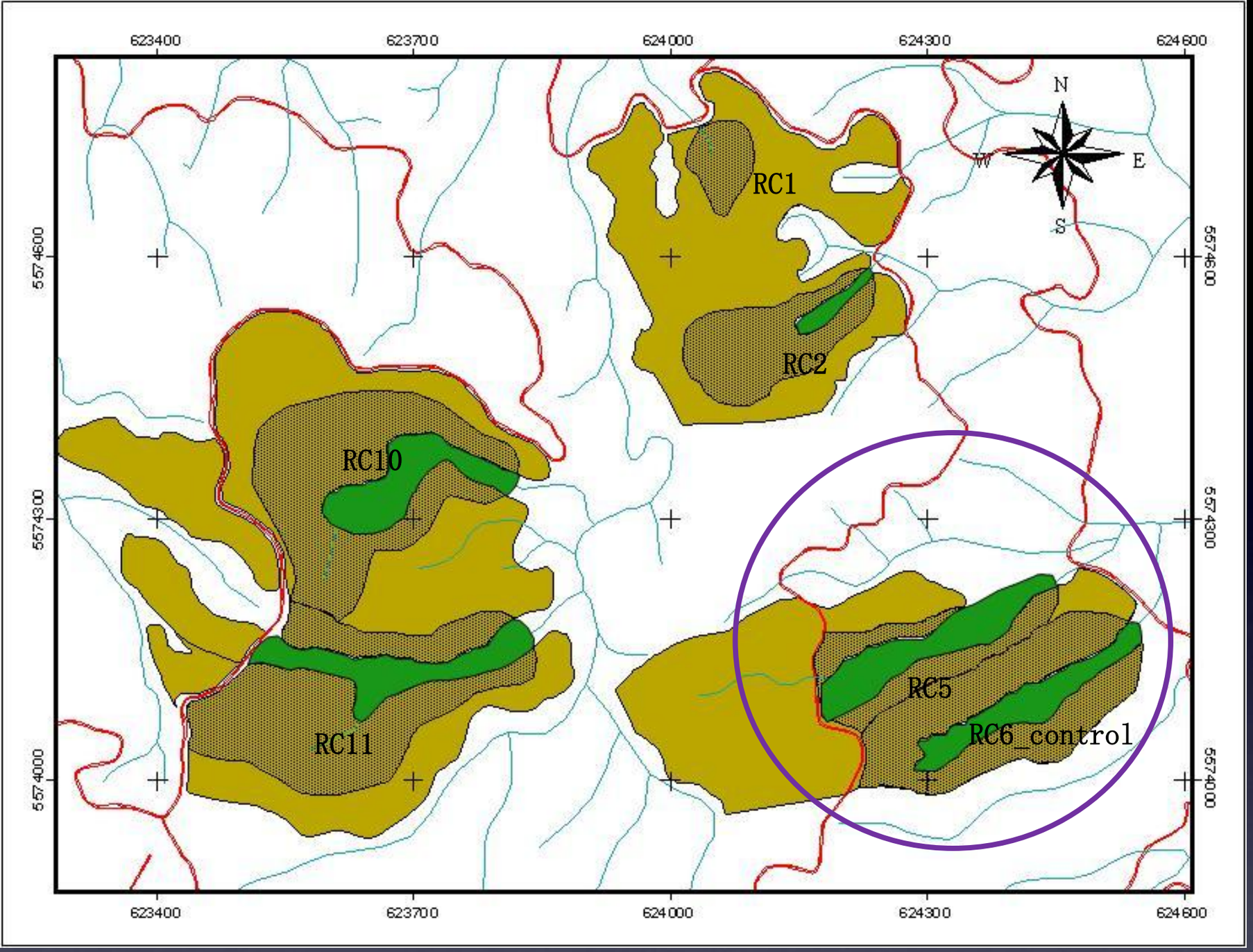

78°
76°
74°
72°
70°
34°
36°
38°
40°
42°
VALPARAISO
Valle de Casablanca
METROPOLITANA
GENERAL BDO. O'HIGGINS
MAULE
BIO BIO
LA ARAUCANIA
LOS RIOS
LOS LAGOS
OCÉANO PACÍFICO
ARGENTINA
Área de estudio
Leyenda
Proyectos de restauración
Bosque nativo
Límite internacional
Límite regional
P.N. Tolhuaca
Villa las Araucarias
Reserva Costera Valdiviana
Predio Los Riscos
Predio Chaqueihua
N
0 50 100 200
Kilómetros


LIBERTAS CAPITUR
UNIVERSIDAD AUSTRAL DE CHILE
FUNDACIÓN
FORECOS

# Monitoring of 10 Experimental watersheds








Stand Age: 11 years

Mean Height (m): 20.4

dbh (cm): 16.5

Stand Density: 1533 trees/ha

Basal Area ($m^2$/ha): 37

Standing Vol: (m3/ha): 288

To be harvested (44.5 ha

Areas within watersheds

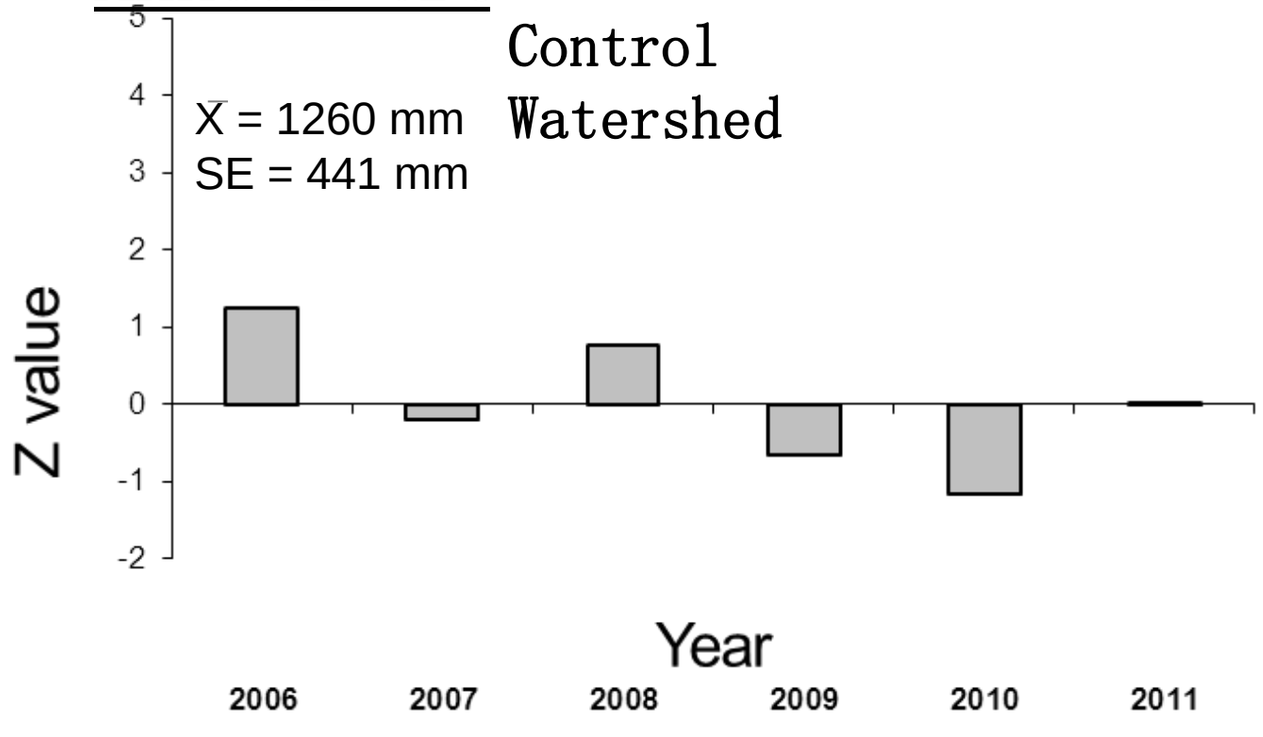
Riparian strips

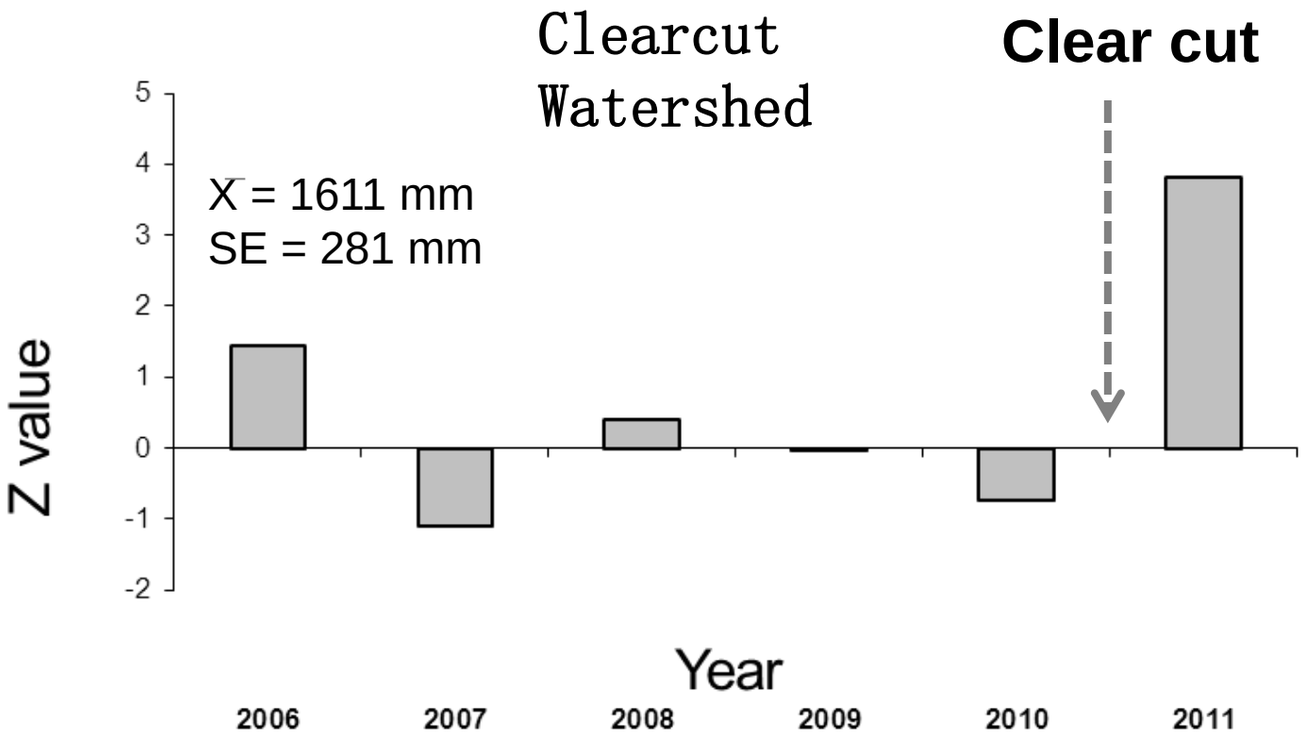
- Clear Cut of Eucalypt plantations February – March 2011-2012 (45 ha)

- Plantation with *Nothofagus dombeyi* (1300 seedlings per ha) plus natural regeneration

# Runoff Coefficients (Runoff/precipitation)

## Annual trends



# Challenging Future Scenario

- Need to continue producing timber and water
- Increase in the demand for water
- Increase in social valuation of water and other ecosystem services

- Climatic change and land use change
  - Decrease in precipitation
  - Increase in temperature
  - Rapid expansion of forest plantations and agriculture

# Regional Problems addressed

1) Scarcity and variability of water resources in Central and Southern Chile.

2) Rapid land use changes in Central and Southern Chile.

# Objectives as stated in Proposal

## Objective 1

Design of landscapes for the combined production of diverse Ecosystem Services

- To analyze and design landscape configurations with different proportions of the various land-use categories and their location that provide a

combined production of market goods and ecosystem services in the watershed (e.g., timber and water provision or multifunctional landscapes) and that are more resilient to changes in the demand, vulnerability and provision of ecosystem services.

## Objective 2

To investigate the recovery of ecosystem services from ecological restoration  under a global ecology approach

•To evaluate the ecological and bio-physical processes that determine the dynamics, resilience, recovery and the restoration potential of water provision as an ecosystem service of forested watersheds.

• To assess the structural and organizational response of the benthic macro-invertebrates community to the variability of streams-flow regimes associated with native forest and exotic plantations watersheds, as a basis for the restoration of freshwater ecosystems.

## Objective 3

To assess the potential of ecological restoration for building resilience, adaptation and mitigation to climate change.

- To evaluate the potential effectiveness of ecological restoration to develop adaptation to climate change to increase water provision and other ecosystem services at various spatial and temporal scales, considering different climate and land use change scenarios.

# Objective 1 Design of landscapes for the combined production of diverse Ecosystem Services

## Purapel (25.000 ha) and Cauquenes (70.000 ha) watersheds

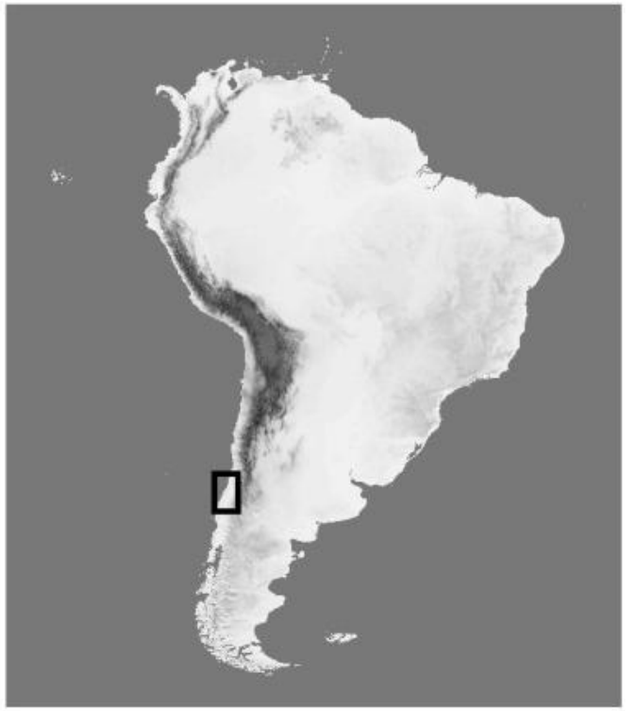
Task 1: Compilation of land use GIS databases and updating of satellite imagery.

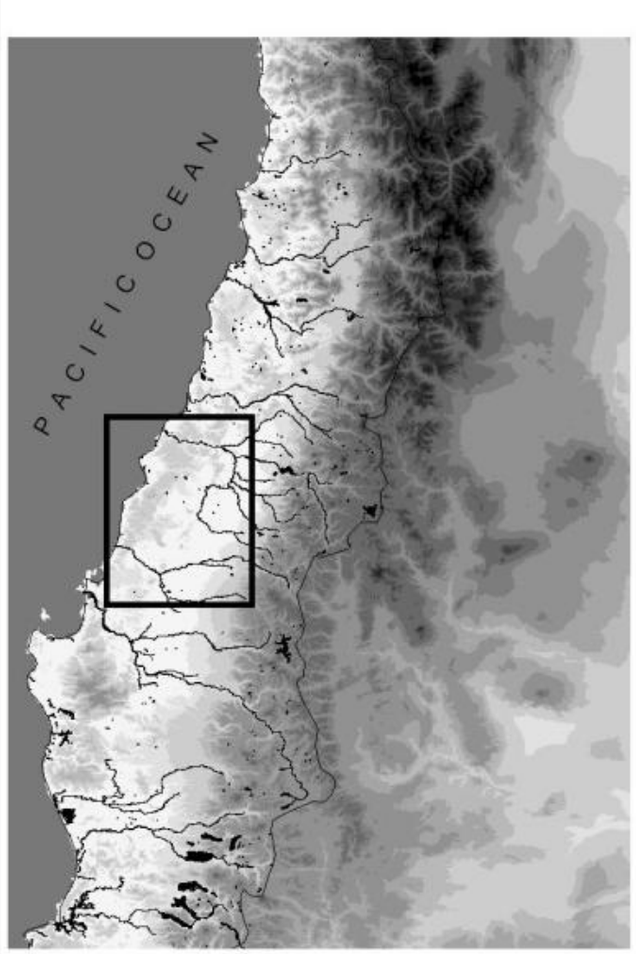
Task 2. Compilation of water rights allocated in the watersheds, their location and time series of their allocation on the watersheds.

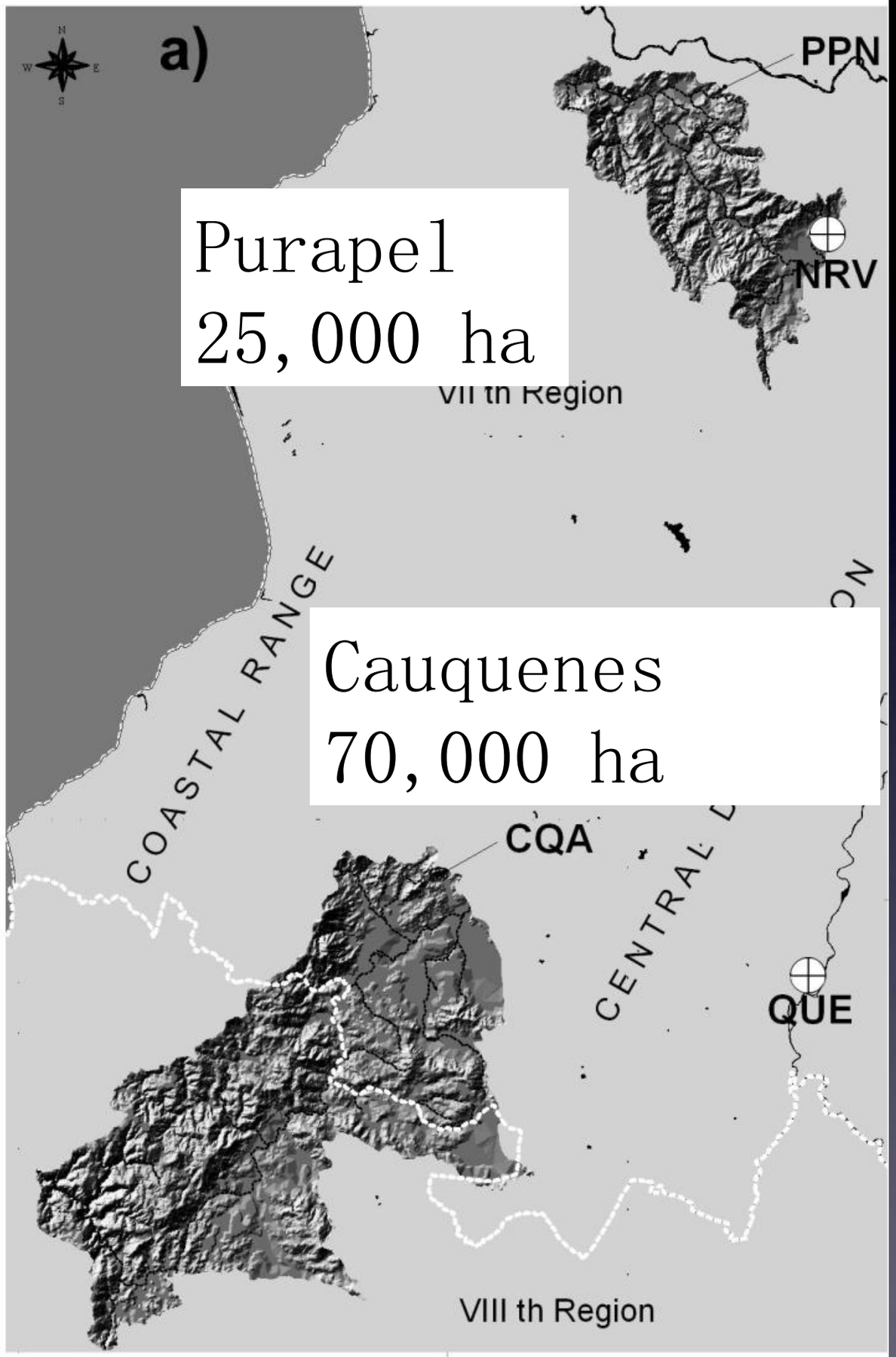
Task 3. Description of the processes and drivers of land use change through logistic regression analysis (e.g. kind of land owners, distance to industries, distance to roads, etc).

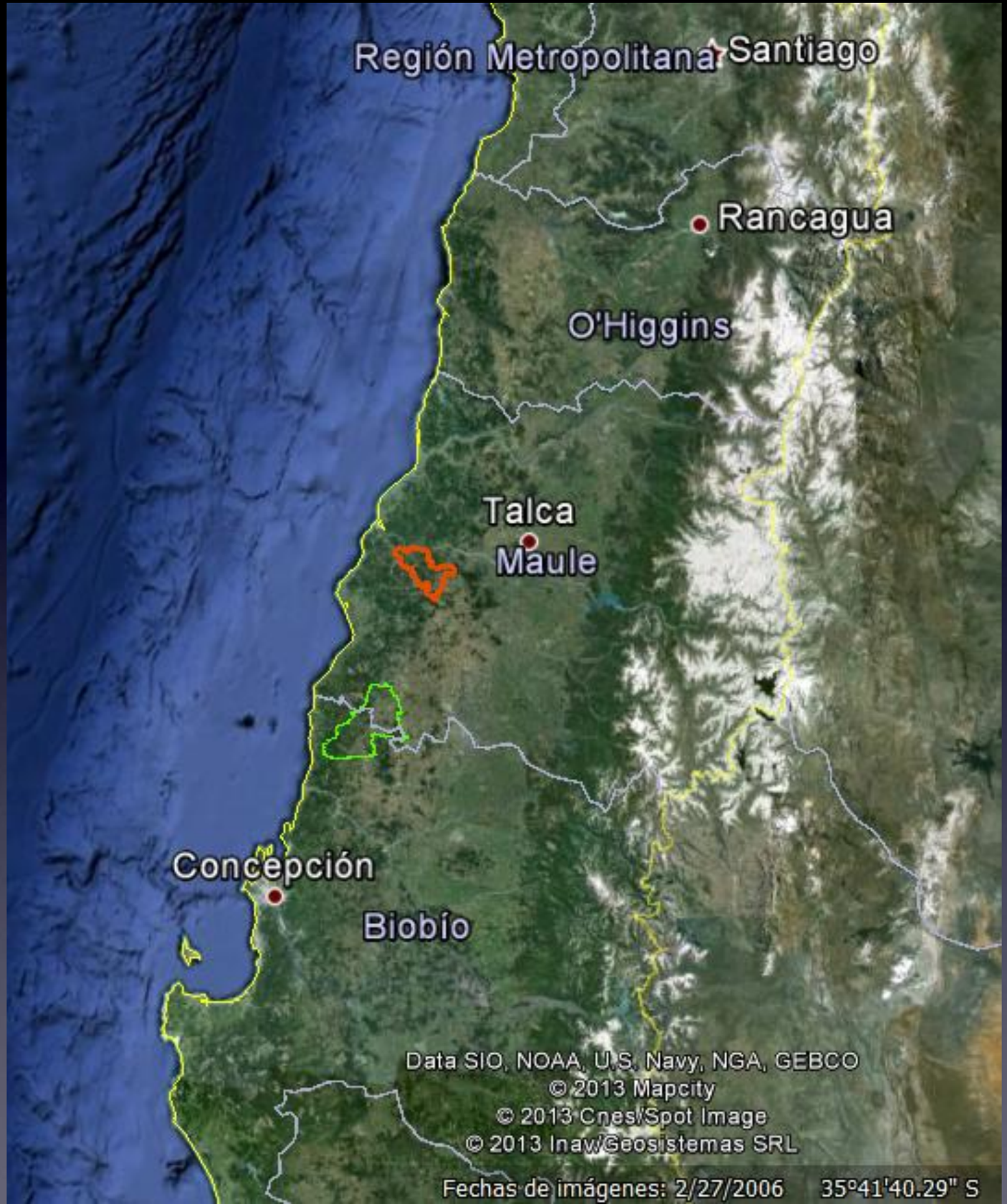
Task 4. Establishment of the statistical relationships between land use change and streamflow trends.

Task 5. Simulations to generate landscape configurations to provide better solutions for a combined provision of multiple ecosystem




PACIFIC OCEAN


a)
N
W
E
S
PPN
NRV
Purapel
25,000 ha
VII th Region
COASTAL RANGE
Cauquenes
70,000 ha
CQA
CENTRAL
QUE
VIII th Region
72° 24'


Región Metropolitana
Santiago
Rancagua
O'Higgins
Talca
Maule
Concepción
Biobío
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2013 Mapcity
© 2013 Cnes/Spot Image
© 2013 Inav/Geosistemas SRL
Fechas de imágenes: 2/27/2006
35°41'40.29" S

Objective 2  To investigate the recovery of ecosystem services from ecological restoration  under a global ecology approach

Reserva Costera Valdiviana (10 watersheds 1 - 175 ha)

Other Study areas (Maule - Los Lagos Regions)

Task 1:  Measure and monitor the regeneration, productivity, carbon balance, resilience and other functional traits of different native forest types, site conditions and disturbances.

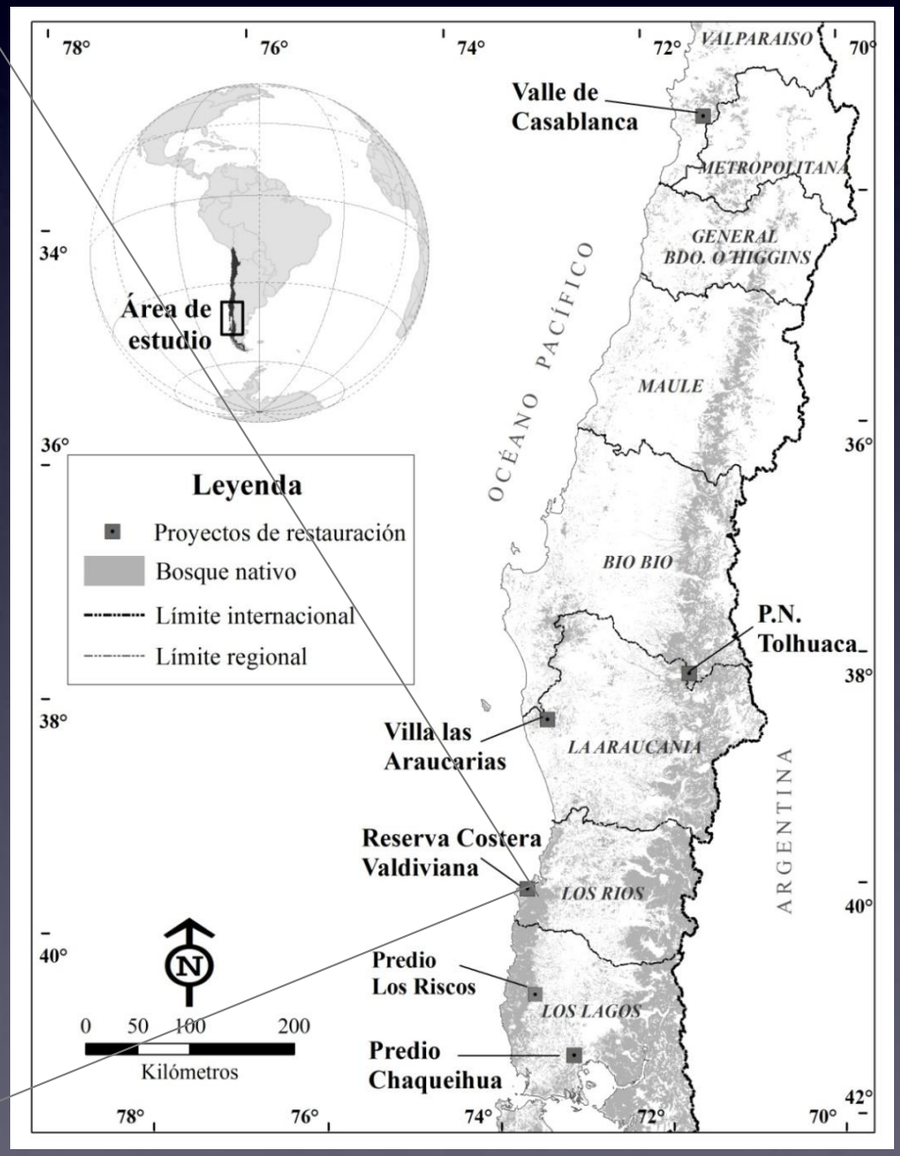
Task 2: Collect field data and monitor permanent plots from areas disturbed by natural and human to assess their natural recovery in different study areas .

Task 4: Monitor of streamflow and water quality of experimental watersheds located in the Valdivian Coastal Reserve (VCR).

Task 5: Conduct studies on ecosystem resilience after disturbances with forests located in other temperate regions, developing indices and protocols.

# Study Area

Océano
Pacífico
South America
Área de Estudio
Bosques Templados
VALDIVIA
Niebla
Corral
Huape
Tres
Chaihuín
Huiro
Punta Galera
40º
Río Futa
Río Colún
Río Chaihuín
Colún
Hueicolla
Río Hueicolla
El Peligro
Río Bueno
LEYENDA
Proyecto de Restauración
Plantaciones de Eucaliptus
Parque Nacional Alerce Costero
Reserva Costera Valdiviana
Ciudades
Hidrología

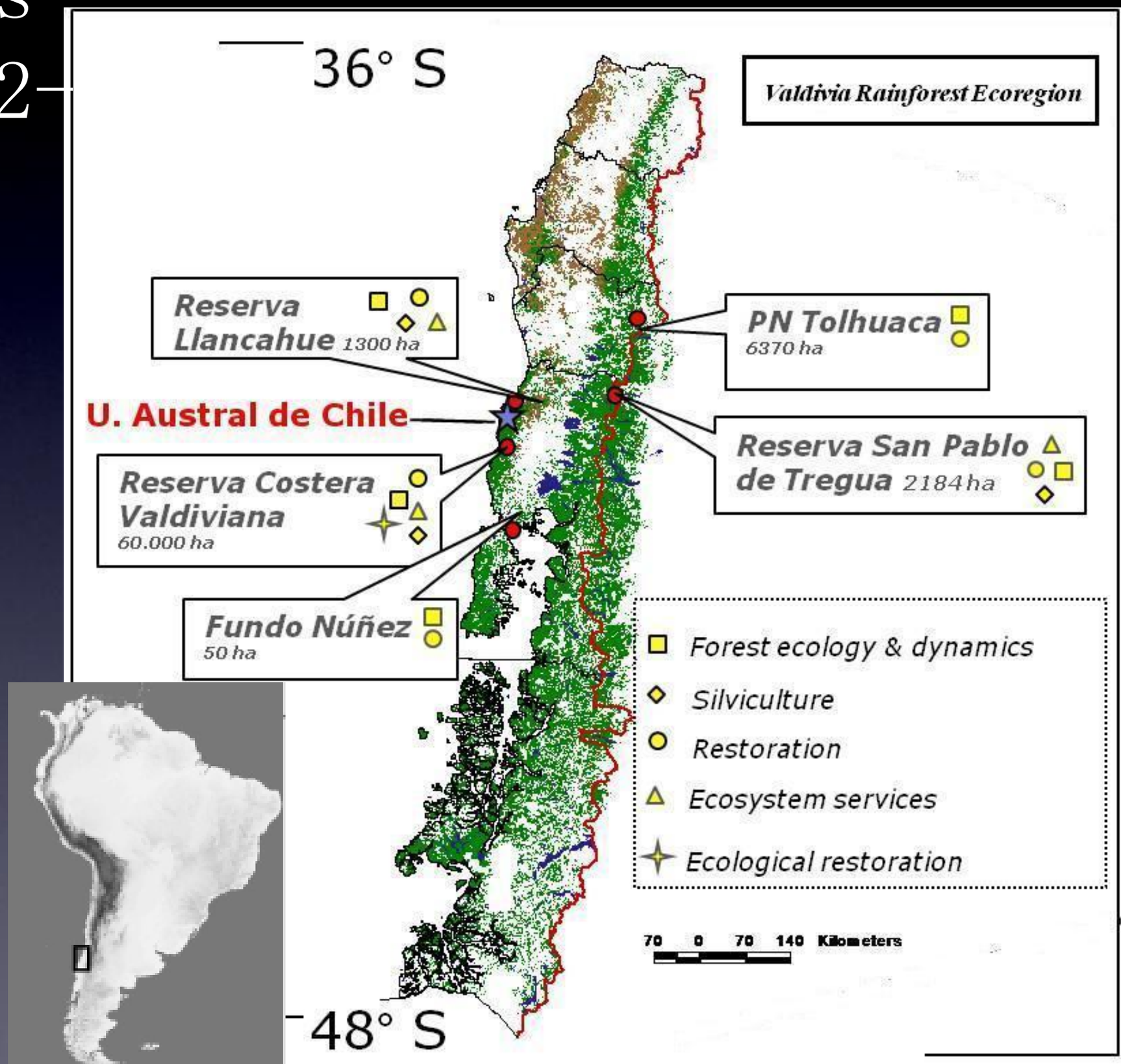

78°
76°
74°
72°
70°
34°
36°
38°
40°
42°
VALPARAISO
Valle de Casablanca
METROPOLITANA
GENERAL BDO. O'HIGGINS
MAULE
BIO BIO
LA ARAUCANIA
LOS RIOS
LOS LAGOS
OCÉANO PACÍFICO
ARGENTINA
Área de estudio
Leyenda
Proyectos de restauración
Bosque nativo
Límite internacional
Límite regional
P.N. Tolhuaca
Villa las Araucarias
Reserva Costera Valdiviana
Predio Los Riscos
Predio Chaqueihua
N
0 50 100 200
Kilómetros

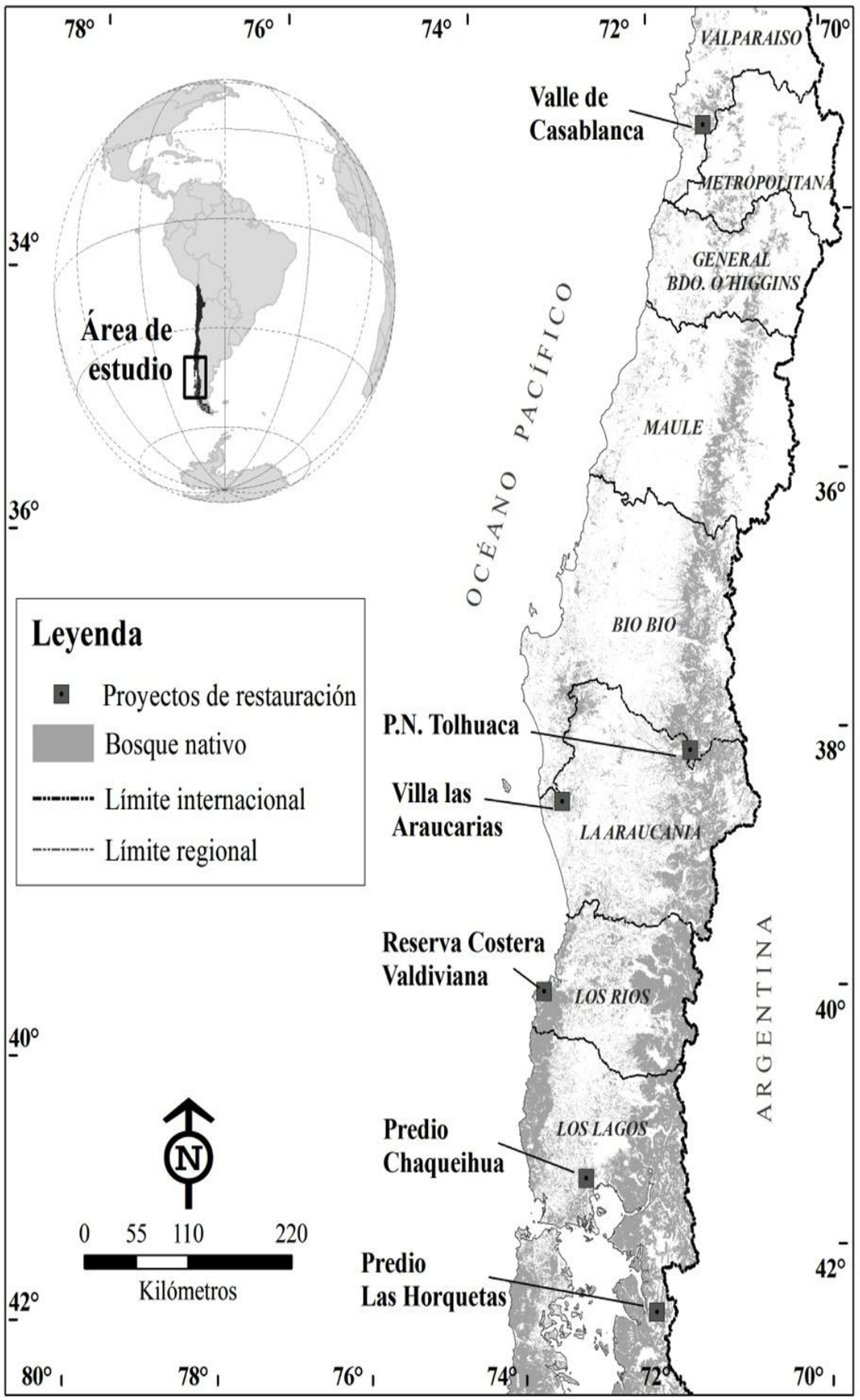
# Long Term Ecosystem Study Sites 2002

## Valdivian Rainforest Ecorregion

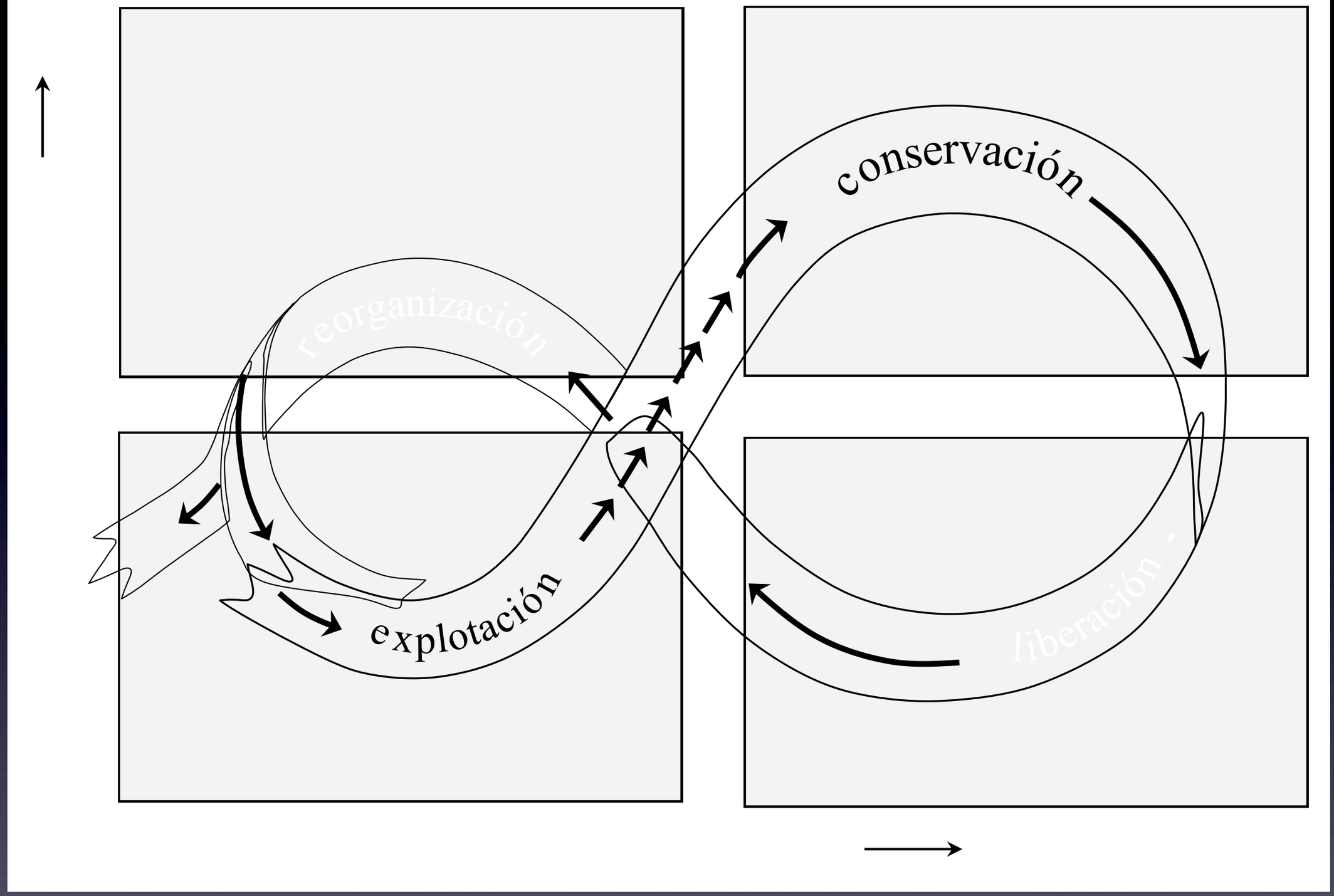
Among Those Highest Conservation Priority Worldwide WWF - WB

- Endemisms
- Threats






- 6 Proyectos de Restauración
- Iniciados desde 1998
- Más de 230 ha
- Involucran a actores muy diferentes: Academia, ONGs internacionales, fundaciones empresas,




Representación de las cuatro fases del ciclo adaptativo para dos propiedades del ecosistema: potencial de crecimiento y conectividad (Holling 2001).
α: iniciación de la sucesión; r: bosque en pleno crecimiento κ: bosques avanzados; Ω: disturbio.

# Effective Restoration

## Ecological Success

Improvement of impaired conditions

Reach environmental quality goals

Self- sustainable Ecosystem

## Socio-
## Economic Success

Participation of Stakeholders

Reach cost-benefit goals

Socio-economic benefits and their equitable distribution

## Learning Success

Knowledg generation

Education

Communication to the public

Development of better practices

From M.A. Palmer et al. 2005

Objective 2  To investigate the recovery of ecosystem services from ecological restoration  under a global ecology approach  Study areas

On the Proposal

Gradient of small selected watersheds in Reserva Costera Valdivian,other in Araucanía, Bío-Bío nested watersheds within Purapel and Cauquenes and other (100 - 5,000 ha)

Task 1: To select the watersheds and streams for sampling the whole benthic invertebrate community on a seasonal basis. with different magnitude of disturbance (pristine native forest, old forest plantations, young plantations and recent clear-cuts).

Task 2 : To determine the taxonomic composition, size distribution, and total abundance of the benthic invertebrate community from watersheds with different disturbance and disturbance history.

Task 3: To develop an index of benthic invertebrate community

Objective 3  To assess the potential of ecological restoration as a mean for building resilience, adaptation and mitigation to climate change

Study areas
Maule to Los Lagos Regions (35° - 43° S)

Task 1: To assess the otential increase in water provision derived from ecological restoration for selected watersheds and upscale these estimates to larger watersheds  and regions.

Task 2.  Analysis of other restoration activities and derived increase in the provision of  ecosystem services with potential to contribute to the resilience and adaptation to climate.

Task 3.  Estimation of the rates and magnitude of increase of the selected ecosystem services in different space and time scales and their comparison with the expected reductions of these services predicted by climatic change and land use change.

Task 5. Economic evaluation of the costs and benefits of the proposed

NIÑOS EN ESCUELAS RURALES Y EL CAMBIO CLIMÁTICO: SIGUIENDO LAS HUELLAS DE AGUA" ED-16001

FUNDACIÓN FORECOS

# Third International Congress on Ecosystem Services of the Neotropics Medellín Colombia

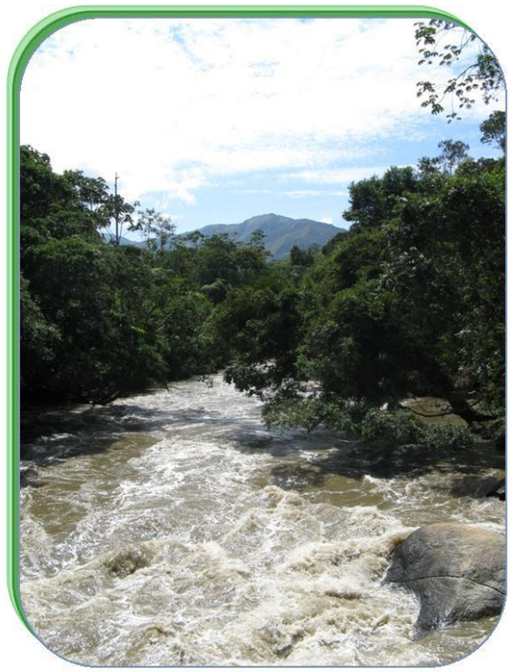
7-11 Oct 2013

www.redproagua.cl

III Congreso Internacional

## SERVICIOS ECOSISTÉMICOS

En los Neotrópicos



Octubre de 2013

MEDELLÍN

Colombia

Organizan:

Otras instituciones vinculadas:

# Development of the science for decision making

## 1 need of a large scale restoration plan for native forests in South-central Chile.

- Design of balanced landscapes with an adequate proportion of forest plantations and native forests for the compatible production of timber and water (quality and quality).

## 2. Restoration of native forests to increase water supply should be a top priority within the National Strategy for the Adaptation to Climatic Change in Chile.

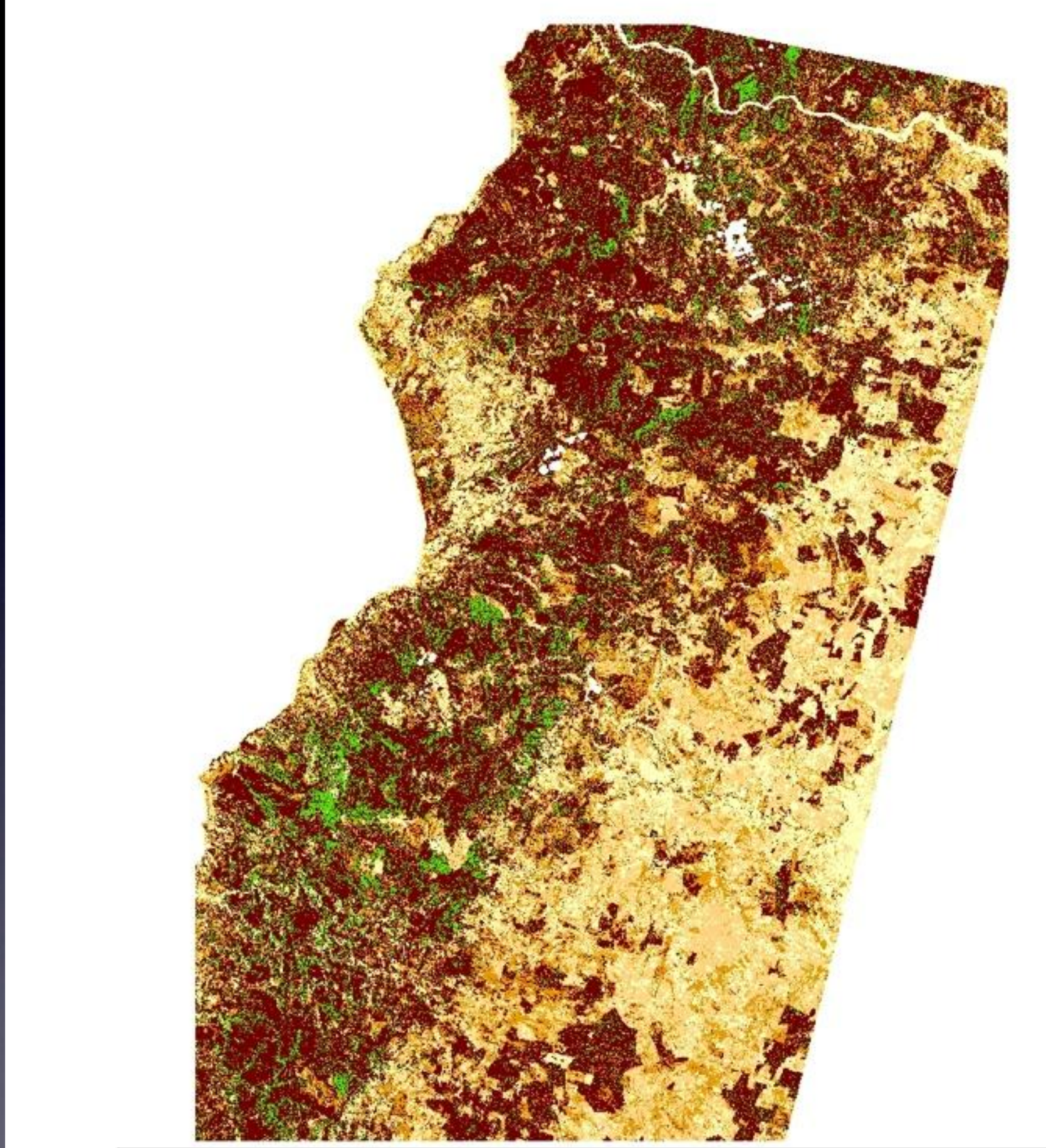
- Significant increase in public and private investment.

- Modifications to current Forest Laws to introduce subsidies for the maintenance and recovery of water provision

# Coastal Sector in Maule Region (0.5 million ha)

2012

- shrubland
- native forest
- agriculture
- plantations



# Coastal Sector in Maule Region (0.5 million ha)

2025

- shrubland
- native forest
- agriculture
- plantations

2010

2003

# Acknowledgements

## Colleagues, students, Institutions

FUNDACIÓN
FORECOS