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# CLIMES
## Impacts of climate change on multiple ecosystem services
# PROCESSES AND ADAPTATION OPTIONS AT LANDSCAPE SCALES

Ecosystems generate a range of goods and services important for human well-being, collectively called ecosystem services. Spatially explicit values of services across landscapes – of central importance also to inform land-use and management decisions – are still lacking. Furthermore, climate change provides a major challenge for the sustainable management of the key ecosystem services and hence sector-specific adaptation measures are needed.

CLIMES is a three-year project, funded by the Academy of Finland and the Chinese Academy of Sciences for the period 1.1.2012 to 31.12.2014. The project seeks – increase the process understanding and develop the methodologies in the context of climate change impacts and adaptation options for spatially explicit values of services across landscapes.

This poster is a brief presentation of the CLIMES project. The project research team brings together experts in forest and landscape ecology, soil and catchment processes, water resources and limnology, remote sensing, system analysis and modelling, and valuation of ecosystem services. The integrative project consists of field studies, statistical analyses of long-term and regional data, modelling, GIS and remote sensing, and ecosystem service accounting. The work will be carried out both at highly instrumented research sites belonging to the International Long Term Ecological Research (ILTER) network in China and Finland, and at larger landscape scales, using data and modelling infrastructures of the participating national research institutes. The study areas are:

- Yanhe Basin, China
- Vanajavesi Basin, Finland



**Fig. 3.** View from Lammi LTER site.

M. Forsius

**Vanajavesi basin, Finland** *(60°40' – 61°20'N , 24°10' – 25°20'E) and its two key study areas in the Lammi LTER site are located in the southern boreal region. The whole catchment area of Lake Vanajanselkä is 2700 km[2] and that of Lake Pääjärvi 220 km[2]. The surface area of Lake Vanajanselkä is 103 km[2] and Lake Pääjärvi 13.4 km[2]. There are 14 municipalities in the study area.*

**Yanhe basin, China,**
*(36°21'–37°19'N, 108°38'–110°29'E) is located in the central Loess Plateau in the middle reach of Yellow River, and has a warm temperate continental monsoonal climate. Yanhe watershed has a very rugged topography with 90% gullied-hilly area. The watershed covers an area of 7687 km[2] with 44 townships in four counties including Zhidan county, Ansai county, Baota district, and Yanchang. The watershed spans three bio-climate zones including forest area, forest-pasture transitional area, and pasture area. Limited water resources and severe soil erosion are characterized as the main environmental problems of this watershed. Therefore, soil and water conservation has long been promoted as an ecological rehabilitation approach in the watershed.*



Yan´an
Xi´an

0  500  1,000  2,000 km

N

Ansai

Yanhe River

Yan'an
Yanchang

0  10  20 km

A. Akujärvi

**Fig. 2.** View from the Yanhe basin.

**Fig. 1.** Yanhe basin, China.

FINLAND
Vanajavesi

## WP1 Water based services

Work package 1 analyses the impacts of changes in key climate drivers on water resources at different spatial scales. The climate effect on erosion processes is of special interest in Yanhe basin, while nitrogen loading is of concern in Vanajavesi. Physical and statistical models will be used and their performance compared at the different study areas. The models to be studied include HBV, INCA, RUSLE and weighted regression analysis. Impact response surfaces will be evaluated to assess probabilities of climate change impacts.
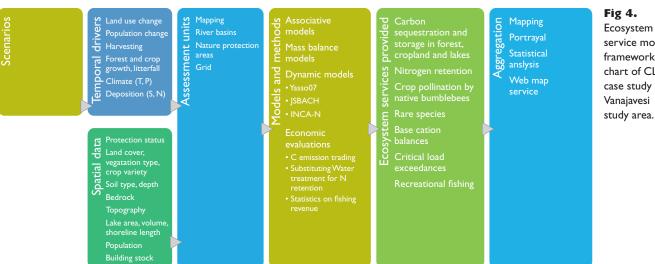
## WP2 Carbon sequestration services

Work package 2 studies the impacts of climate and land-use change on soil and ecosystem carbon sequestration process at different spatial scales. JSBACH land-biosphere model and Yasso07 soil carbon model will be used in the analysis. In the Finnish study area, an evaluation of the carbon balance of forests, cropland and lakes will be performed both on the catchment scale and with simplified calculation methods on the municipal scale.

## WP3 Spatial extrapolation and ecosystem service valuation

Work package 3 integrates the results of WP1 and WP2 and develops methodologies for spatial extrapolation and integrated modelling of the ecosystem services. This includes the valuation of ecosystem services and their interactions in terms of trade-offs and synergies. In the Finnish study area, also the prevalence of key endangered species will be assessed.

## Expected results of the CLIMES project include:

- New process understanding about the controls, interactions and trade-offs of ecosystem services of key national importance.
- Development and application of advanced mathematical and extrapolation tools for simulating impacts of future climate and land-use scenarios, and assessment of adaptation options.
- Enhanced cooperation and integration of knowledge between ecosystem researchers in China and Finland.
- Training of students and opportunities for Post Doc researchers.



**Fig 4.** Ecosystem service modelling framework. Flow chart of CLIMES case study in Vanajavesi study area.

*Selected CLIMES publications*

Forsius M, Anttila S, Arvola L, Bergström I *et al.* 2013. Impacts and adaptation options of climate change on ecosystem services in Finland: a model based study. *Curr Opin Environ Sustain* 5(1):26–40.
Fu B, Forsius M, Liu J 2013 (Eds.). *Curr Opin Environ Sustain Terrestrial Systems Special Issue* 5(1).
Fu B, Wang S, Su C, Forsius M 2013. Linking ecosystem processes and ecosystem services. *Curr Opin Environ Sustain* 5(1): 4–10.
Vanhala P, Repo A, Liski J 2013. Forest bioenergy at the cost of carbon sequestration? *Curr Opin Environ Sustain* 5(1): 41–46.
Vihervaara P, D'Amato D, Forsius M, Angelstam P *et al.* 2013. Using long-term ecosystem service and biodiversity data to study the impacts and adaptation options in response to climate change: insights from the global ILTER sites network. *Curr Opin Environ Sustain* 5(1): 53–66.

*References to models used in CLIMES*

- INCA-N and Weighted Regression
  Rankinen K, Granlund K, Futter MN, Butterfield D *et al.* 2013. *Bor Env Res* 18.
  Hirsch RM, Moyer DL, Archfield SA 2010. JAWRA 46(5): 857–880.
- Yasso07 and JSBACH
  Tuomi M, Laiho R, Repo A, Liski J 2011. *Ecol Mod* 222: 709–718.
  Thum T, Räisänen P, Sevanto S, Tuomi M et al. 2011. *J Geophys Res* 116, G02028.

*Links to networks*

- Chinese Ecosystem Research Network www.cern.ac.cn:8080/index.jsp
- Finnish LTER-network www.environment.fi/syke/lter