

Xiangzheng Deng

A Spatial Decision Support System for Agriculture and Natural Resources Management in China

- Need to take decisions and make critical day-to-day and long-term planning on **agricultural and natural resource** management (strategic and tactical).
- Supports have to be relevant, timely, user-friendly to assist and manage crop cultivation. **Decision Support System(DSS)** offers scientific-technical tools to combine skills and experience.

Outline of this talk

- Background
- Framework
- An application
- Development prospect

As we all know,

compared to geographical factors, anthropogenic factors need to be paid more attention with.....

Agricultural condition monitoring system



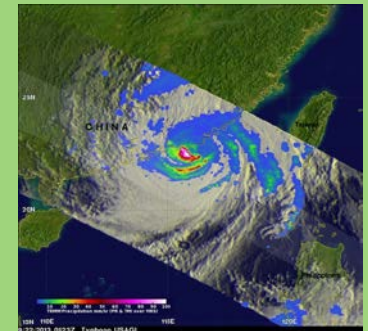
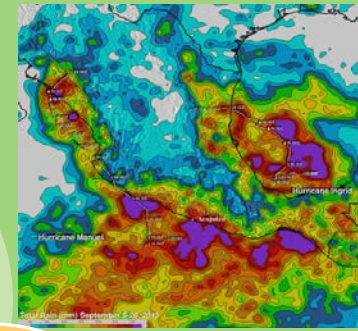
<http://www.dsac.cn/>



<http://tm.arcgisonline.cn:8038/>

Meteorological and hydrological monitoring and forecasting system

Floods in Mexico Super Typhoon
2013.09.20 2013.09.22



Climate

Geo-environment System

Land

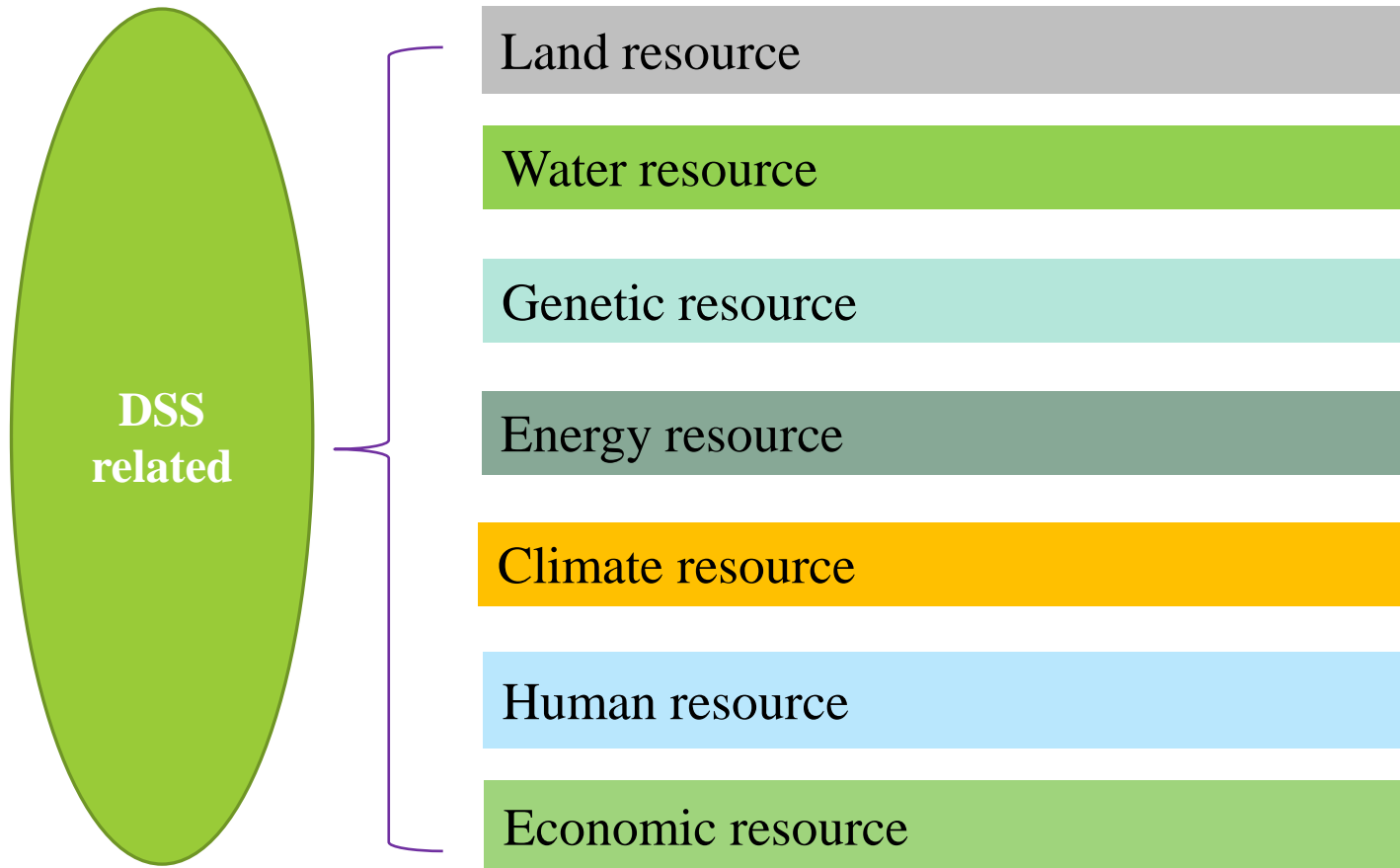
Human

Human domains



It is difficult to provide timely and effective decision support for **agriculture and natural resources management** due to the lagged behind observation of human dimensions.

Categories of natural resources closely linked with agriculture



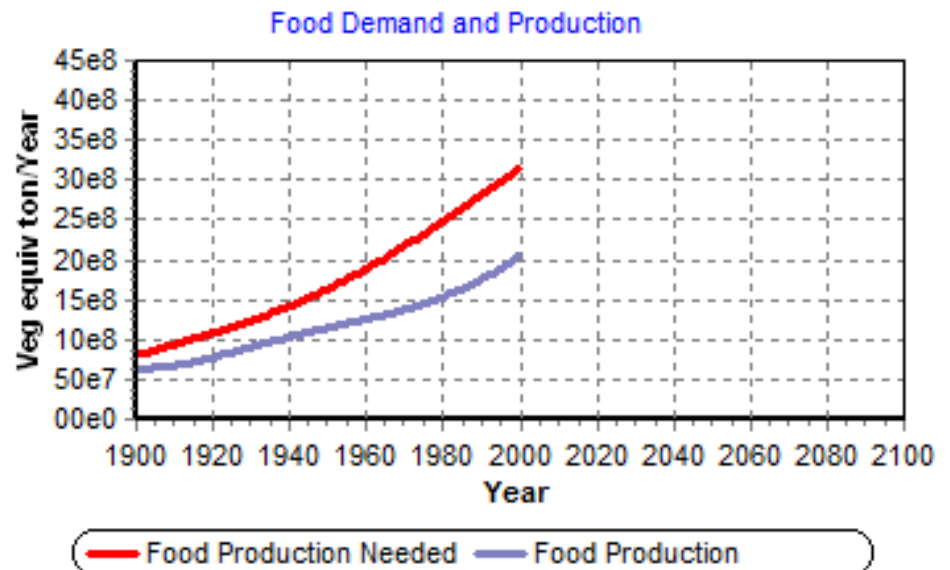
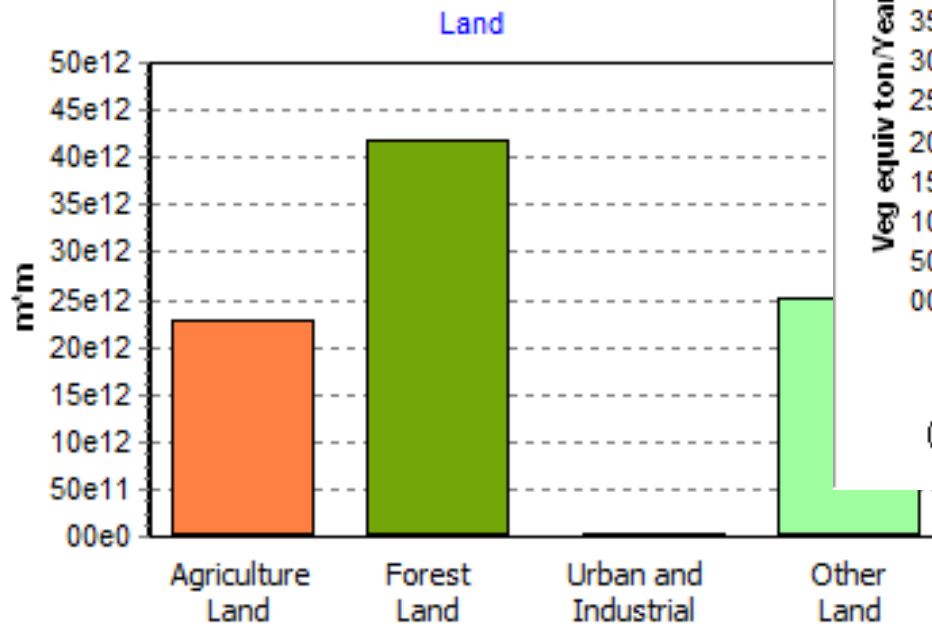
Decision Support System(DSS)

while used in agricultural and natural resource management, DSS is with specific features:

- Aim at promoting areas of **agriculture and natural resources management** of all disciplines ;
- A comprehensive **collection** to disseminate knowledge and information on these fields ;
- A **platform** with the debate and dissemination of the research fields and directions with practical applications.

Decision Support System(DSS)

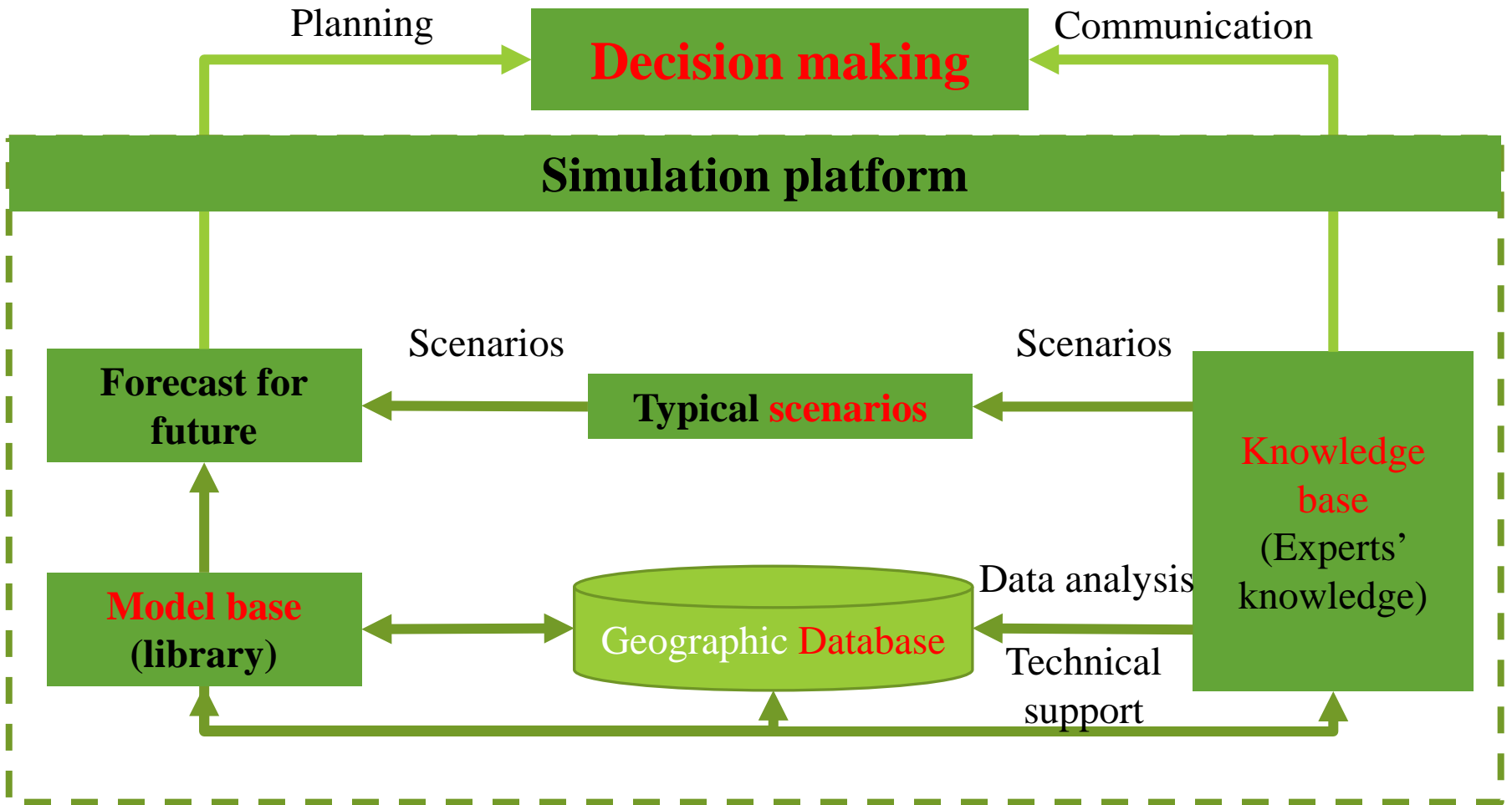
A coupled human–environment system. It is an integrated scientific framework for studying the interface and reciprocal interactions that link human (e.g., economic, social) to natural (e.g., hydrologic, atmospheric, biological) sub-systems of the system.



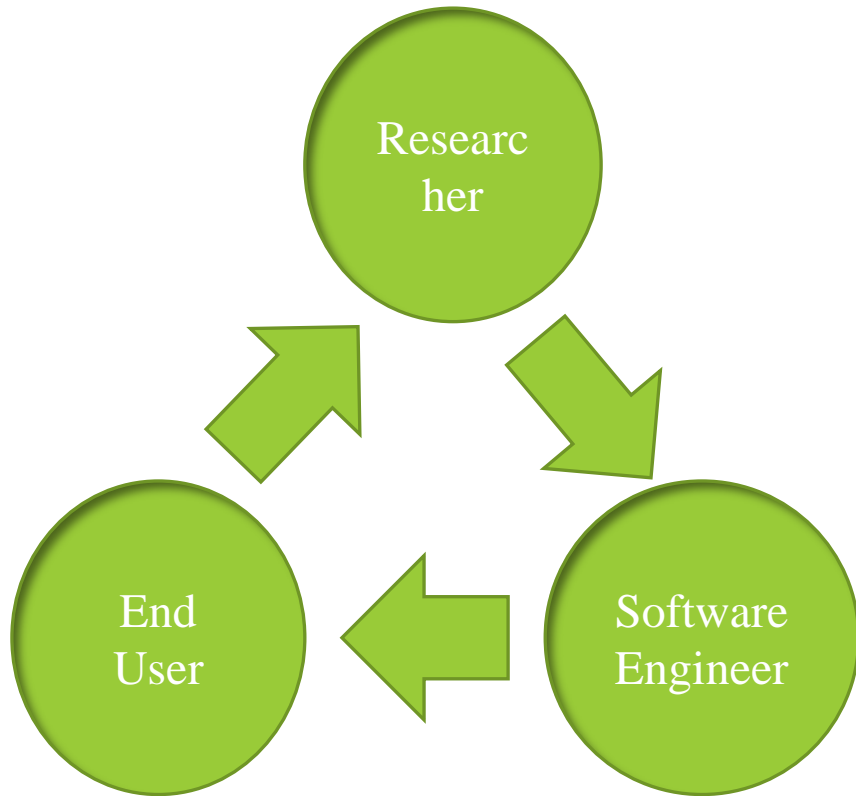
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Framework of a Spatial Decision Support System



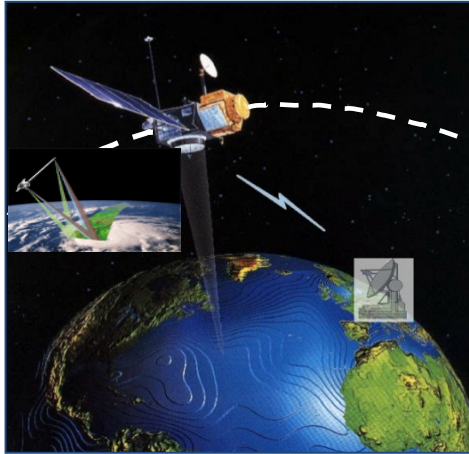
Design of a Spatial Decision Support System



- Adaptive and integrative tools and strategies for natural resources management;
- The outcome of the project should be a tool-box for integrated **agriculture and natural resources**;
- The expected impact is a long-term **integrated management of natural resources**.

Data collection/handling

Six approaches



Remote sensing



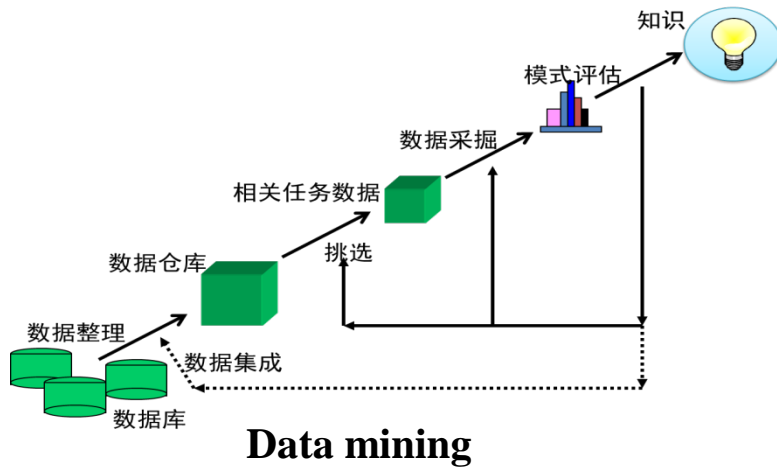
Field monitoring



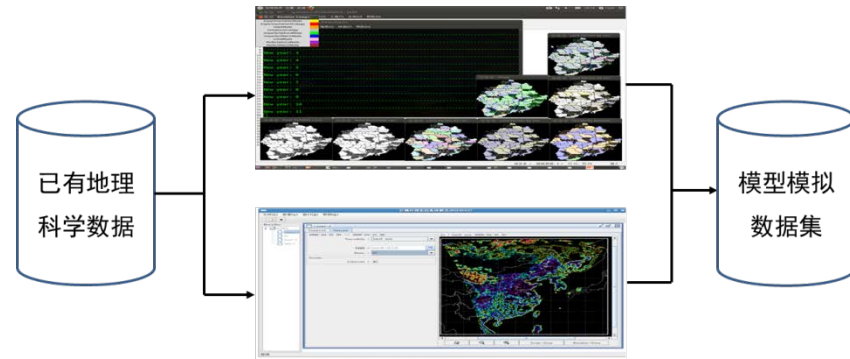
Field survey



Historical data

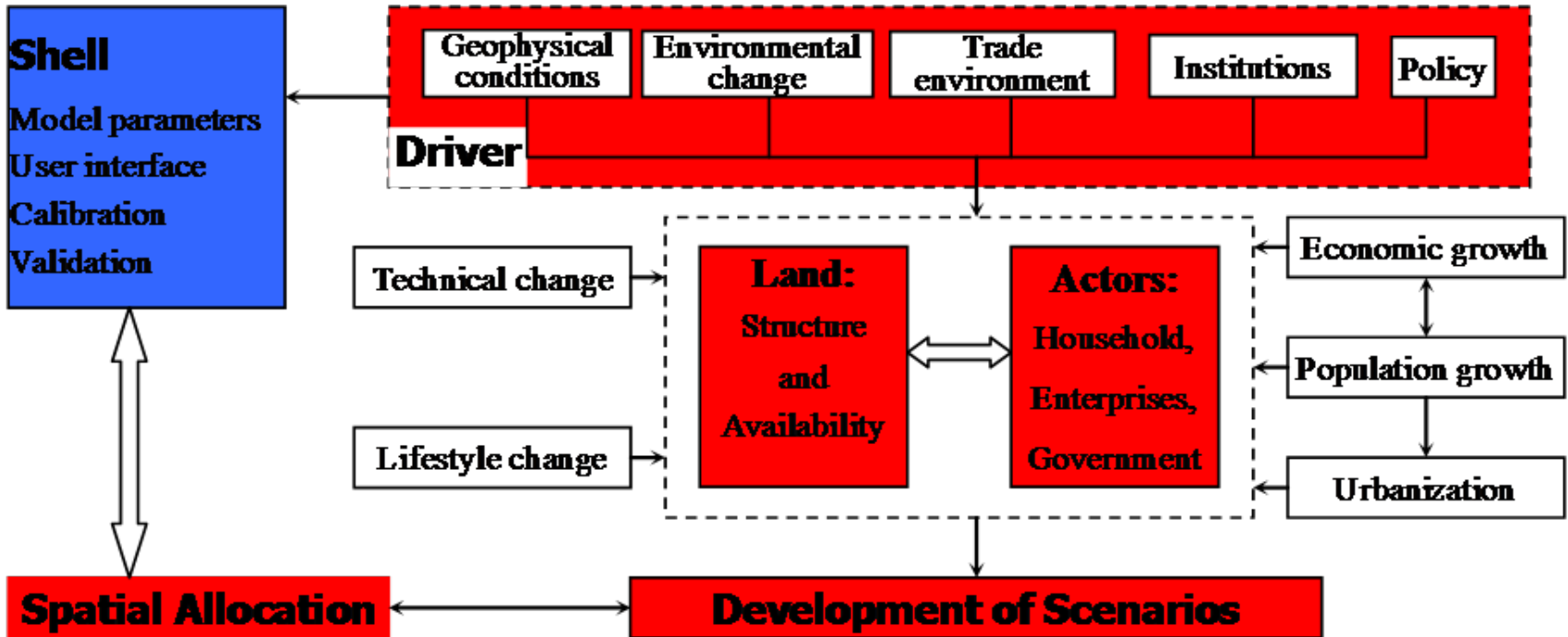
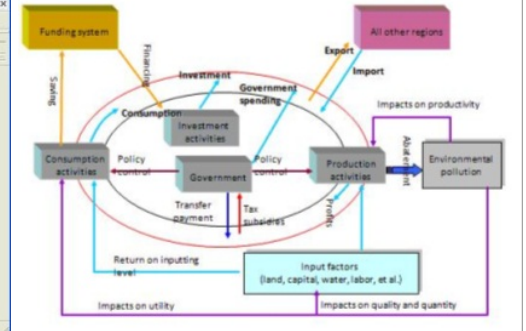
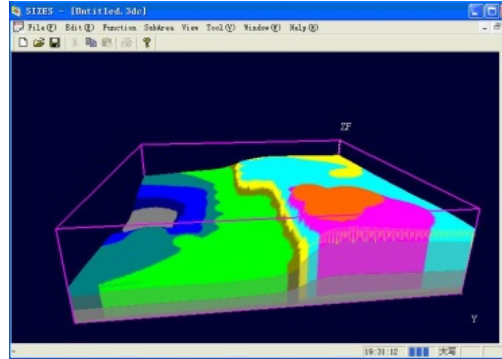


Data mining



Model Simulation

Prediction of the outcomes along with the scenario-based development paths



Final outputs of DSS

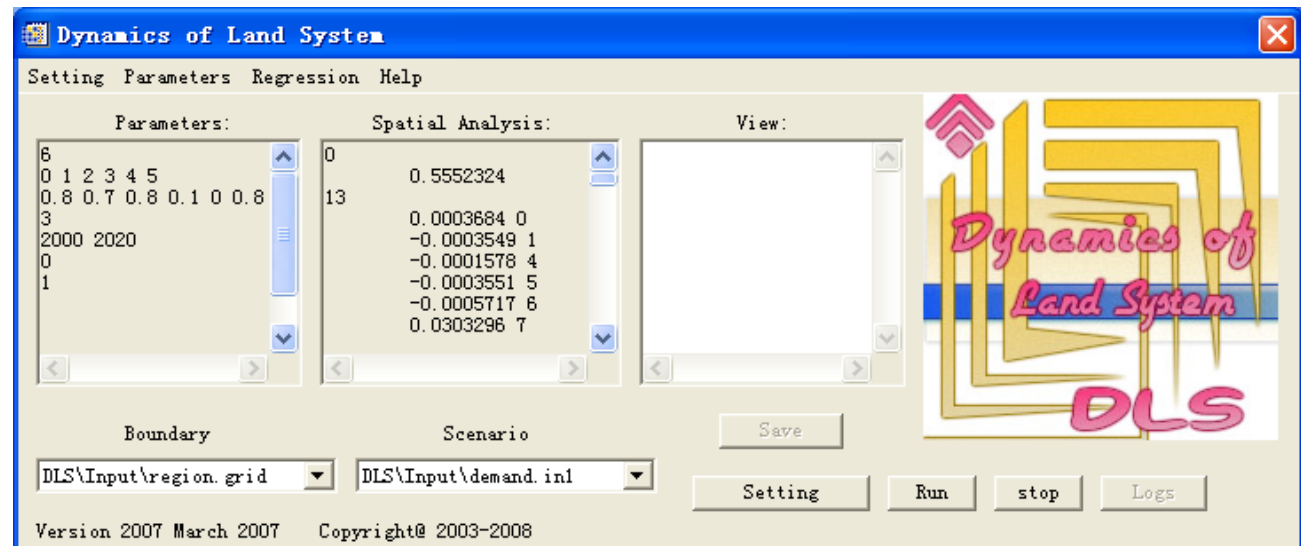


...to deliver:

- **Guidance document**
- **Toolbox**
- **Training course(modules)**
- **Policy briefs**
- **Publications**

Toolbox of DSS

- Database with tools + standard
- Several keys to find tools in the database
- Wizard, queries, ..
- Interaction with online guidance
- Possibility to add tools, cases, ..

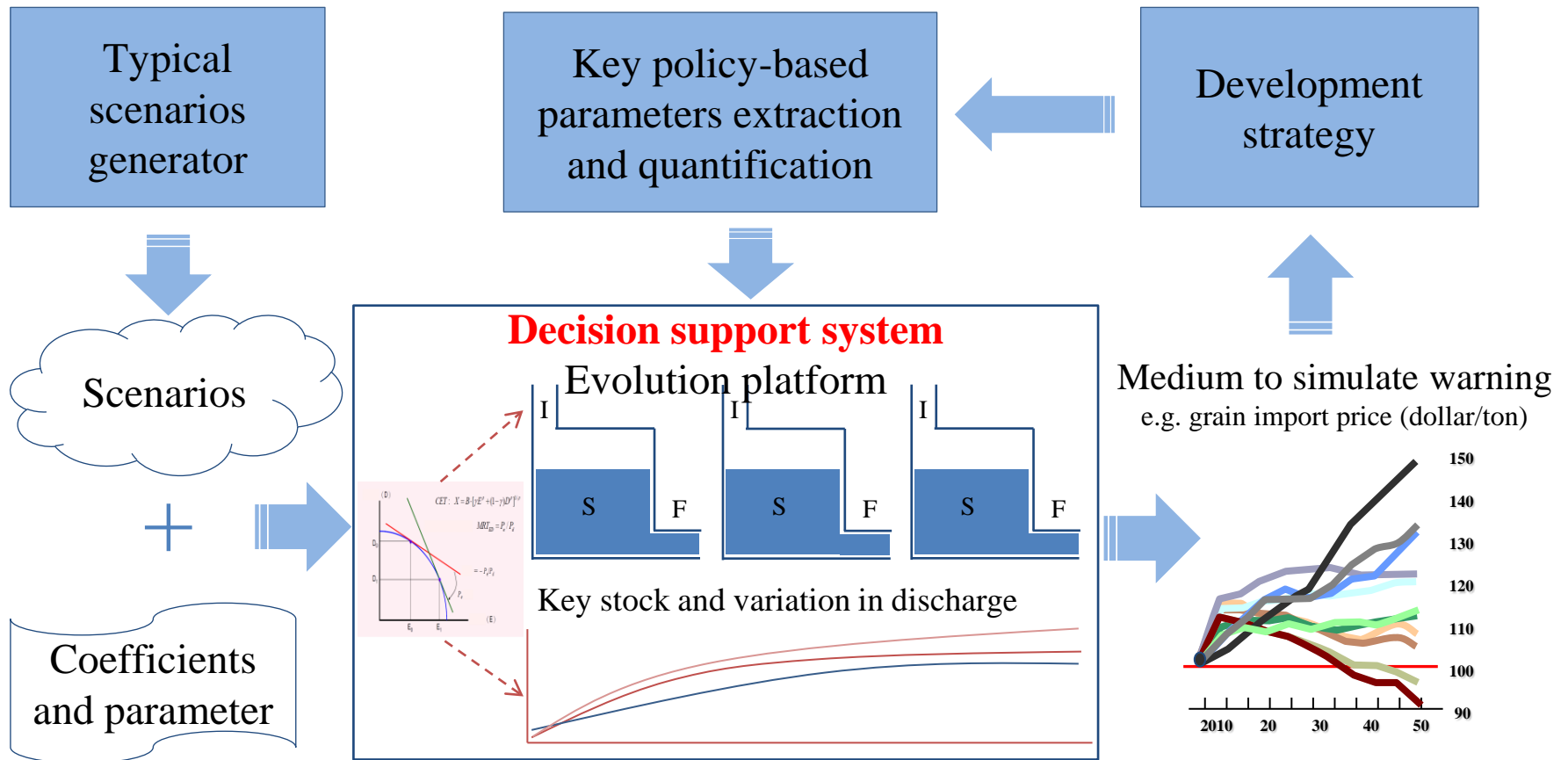


Outline of this talk

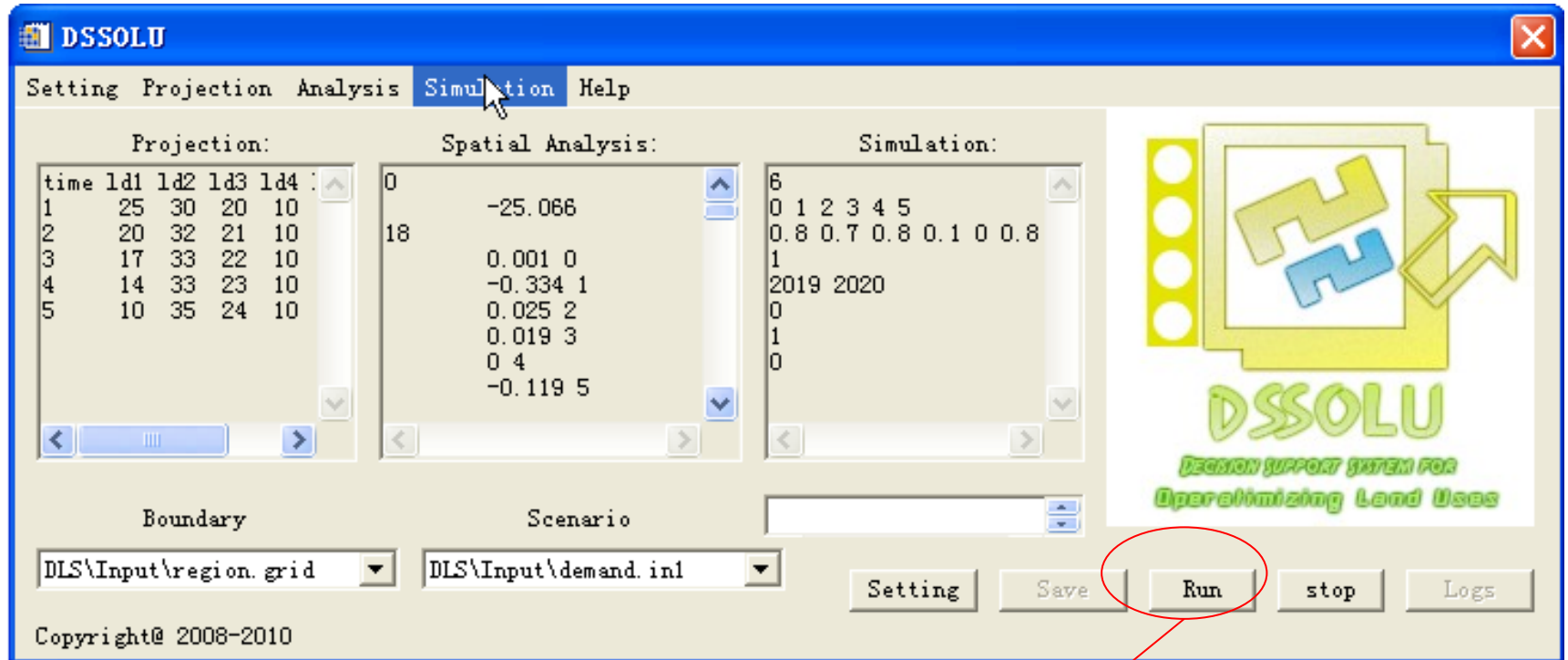
- Background
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An Application in Yunnan province

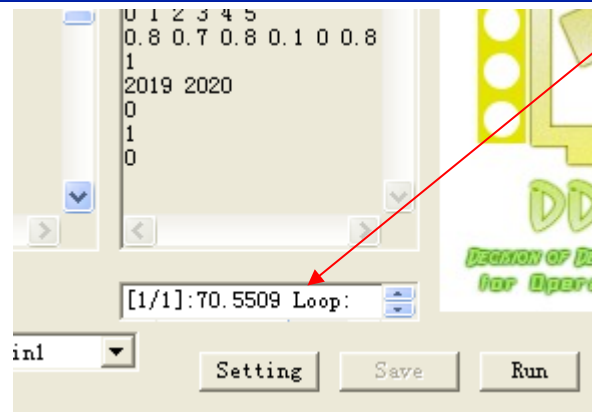
A spatial decision support system provides suggestions for the sloping land development in Yunnan province



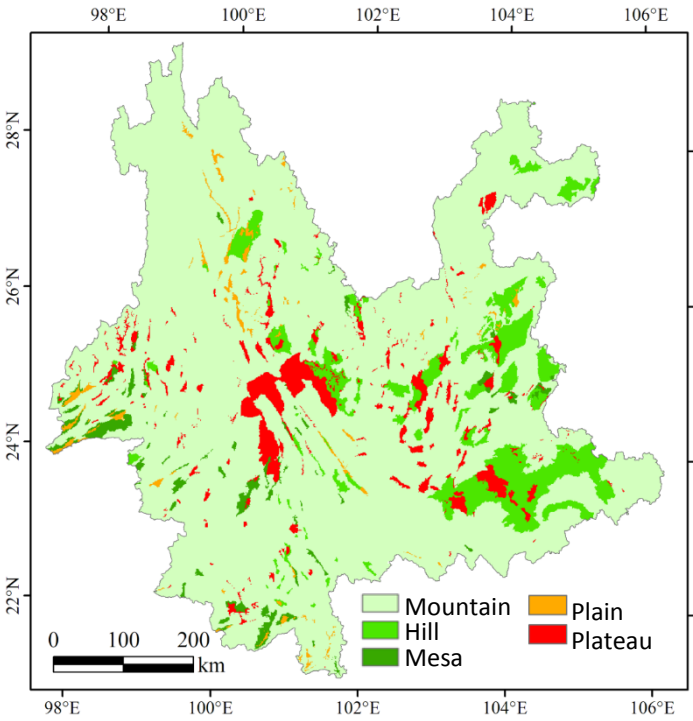
An application in Yunnan Province



Decision support platform for the agricultural development as well as the vulnerability of natural disasters

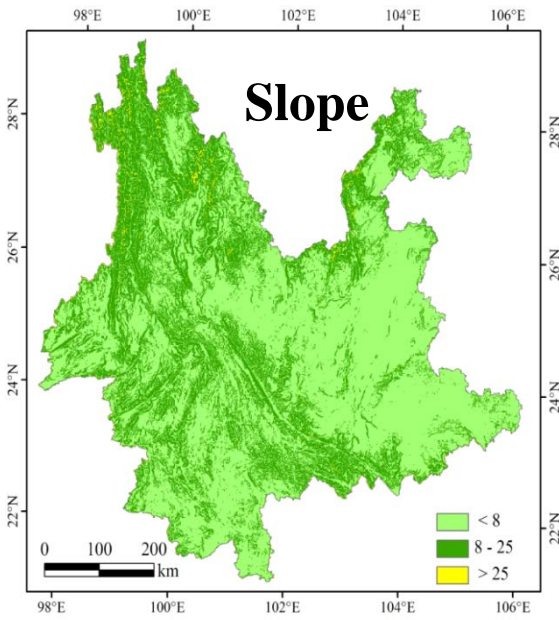
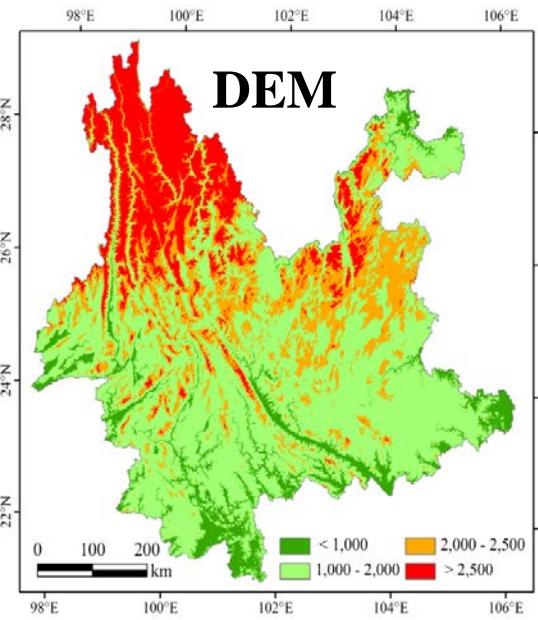


Case study in Yunnan Province



- Altitudes up to 2000 meters;
- Reserved land resources are mostly located in the mountains, where altitude is lower than 2500 m while with steep slope.

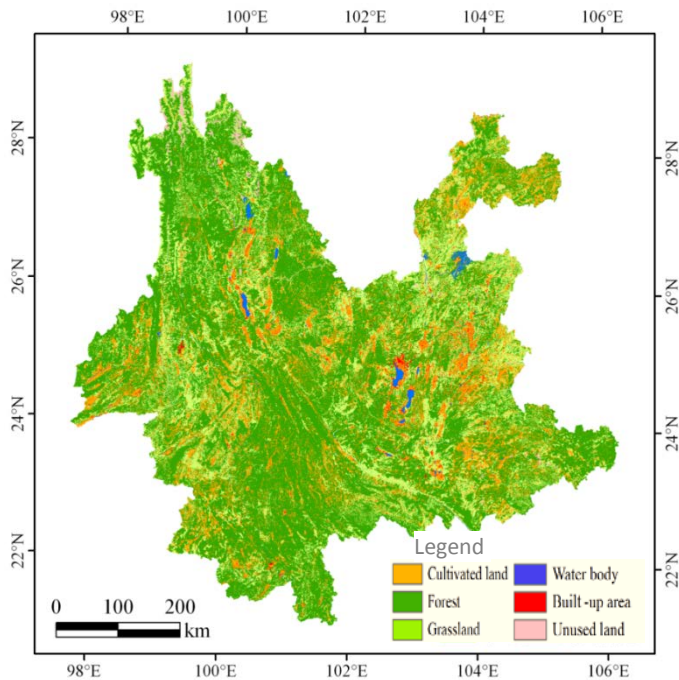
Total area of Yunnan is about 390 thousands km².
Mountains and plateaus cover **94%** of the total area.



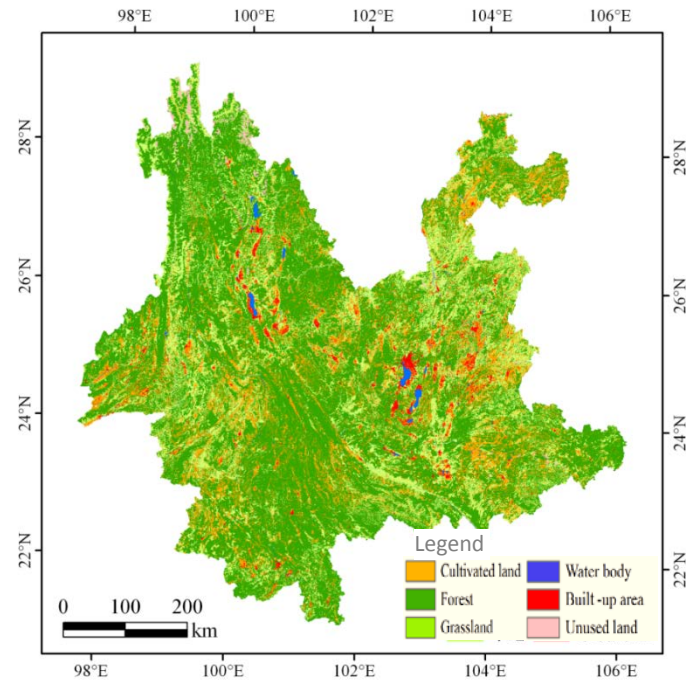
Local characteristics

Rapid expansion of built-up area exert great effects on:

- low natural and ecosystem carrying capacity,
- water loss and soil erosion,
- surface runoff.

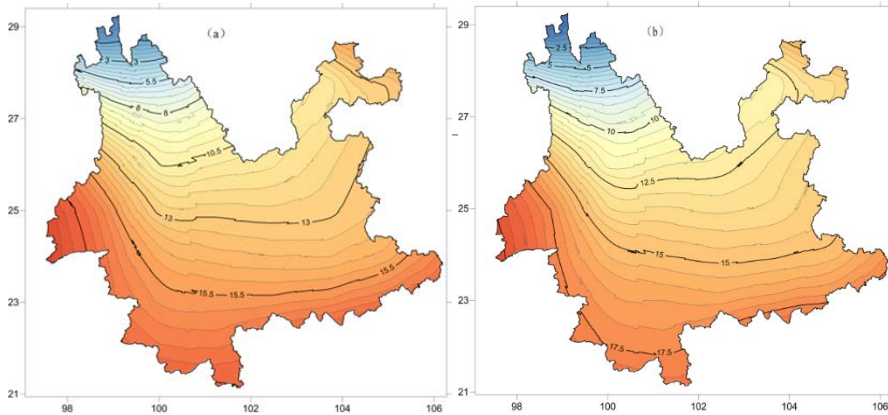


1988

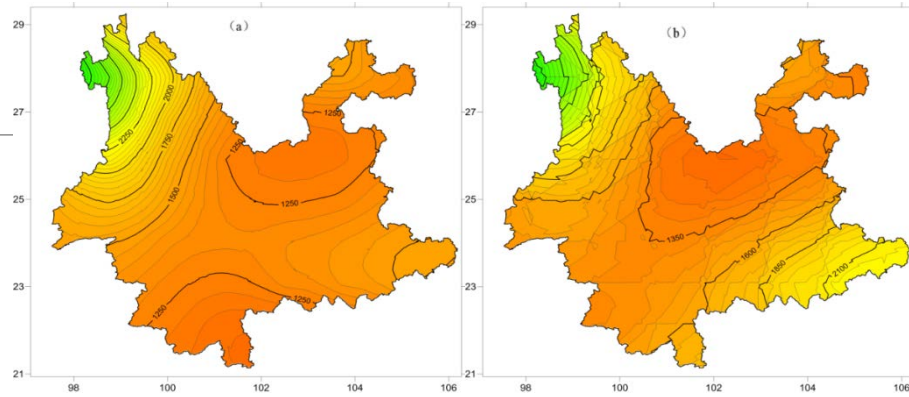


2008

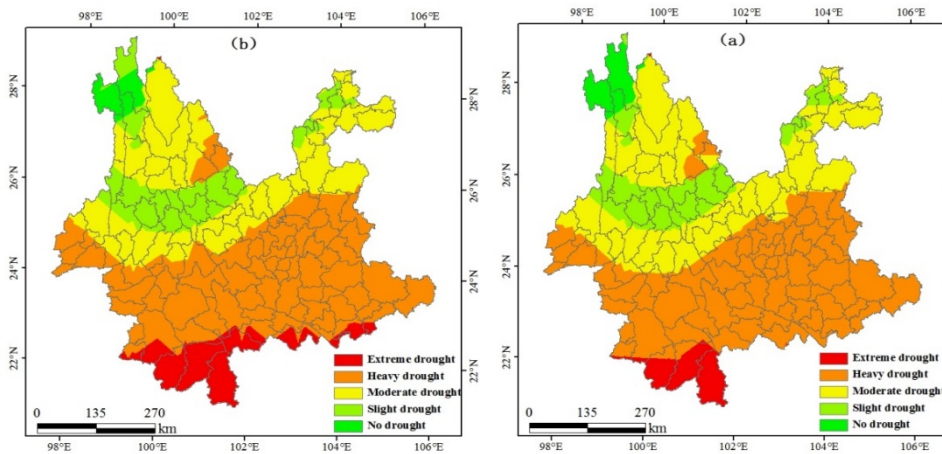
Local characteristics



Spatial heterogeneity of the air temperature at 2m above the ground in Yunnan province during 2020-2030 (Unit: °C)



Spatial heterogeneity of precipitation in Yunnan province during 2020-2050 (Unit: mm)



Spatial pattern of the risk of drought in Yunnan province during 2020-2050

- Time-series data suggests the temperature of the same place will steadily increase by $0.5^{\circ}\text{C}/10$ years;
- Precipitation in the northwest part will show a first decreasing and then increasing trend, first reaching 2850mm in year 2020, then declining to 2650mm in year 2030.

Challenges

- Lack of the geological hazard/ecological monitoring network
- Incomplete monitoring indicator system
- Weak capability of disaster monitoring
- Remote-sensing based monitoring network
- Lagged behind identification of risk threshold

Key research tasks

In-site monitoring of geological hazards of mountain development

Ecological environment back ground data of the research area

In-site monitoring of environment of mountain development

Build up **agricultural and natural database** for early warning geological hazard

Real time database of the ecological risk and geological hazards monitoring

Design models, calibration, validation and efficiency evaluation of models

Geological hazards process simulation

Building extraction of remote sensing image analysis

Ecological risk assessment model

Extract key parameters for improving models, analyze thresholds of the simulated system

Evaluation method of the implementation of land use planning

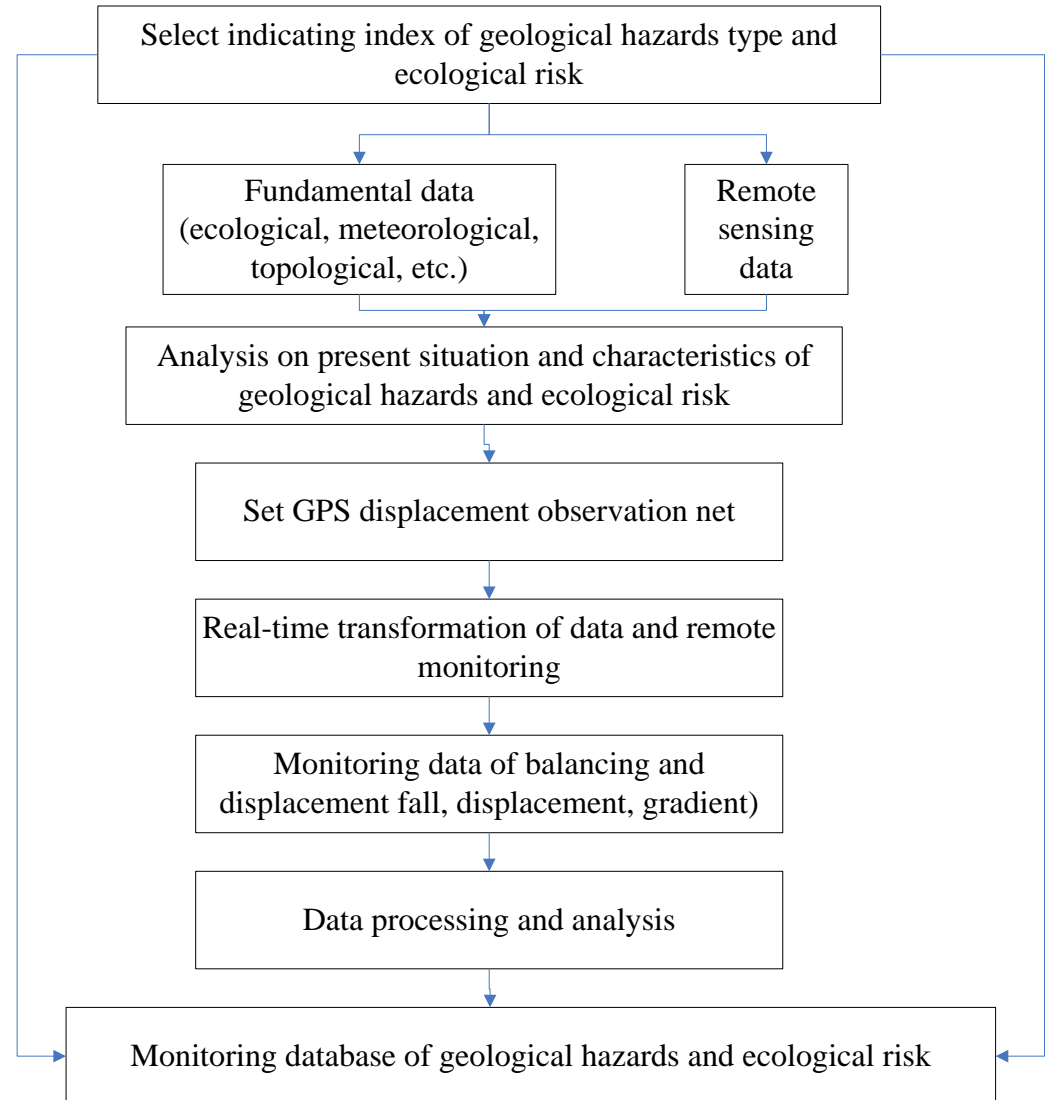
Geological hazards and ecological risk monitoring of low hilly mountain

Integrate systematic analysis for **agriculture development and natural disaster relief**

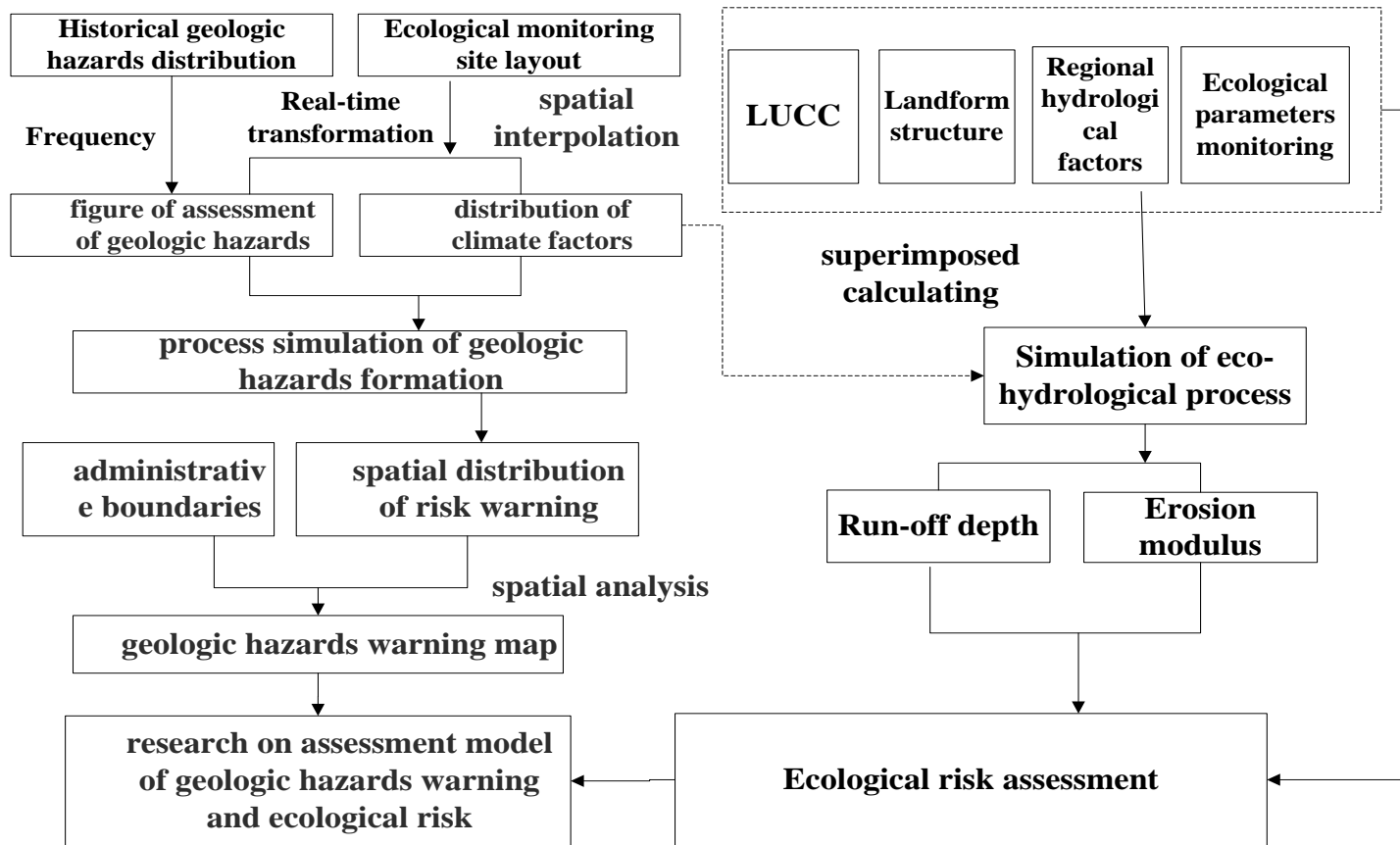
Land use regulation measure and suggestion for low hilly mountain development

Work package #1

- Collect spatial data of agriculture and nature disaster risk etc.
- Select the demonstration area and build the GPS observation net to monitor adjustment and displacement
- Lay automatic sensor equipment
- Develop the monitoring database of agriculture and nature disaster relief based on memory access technology



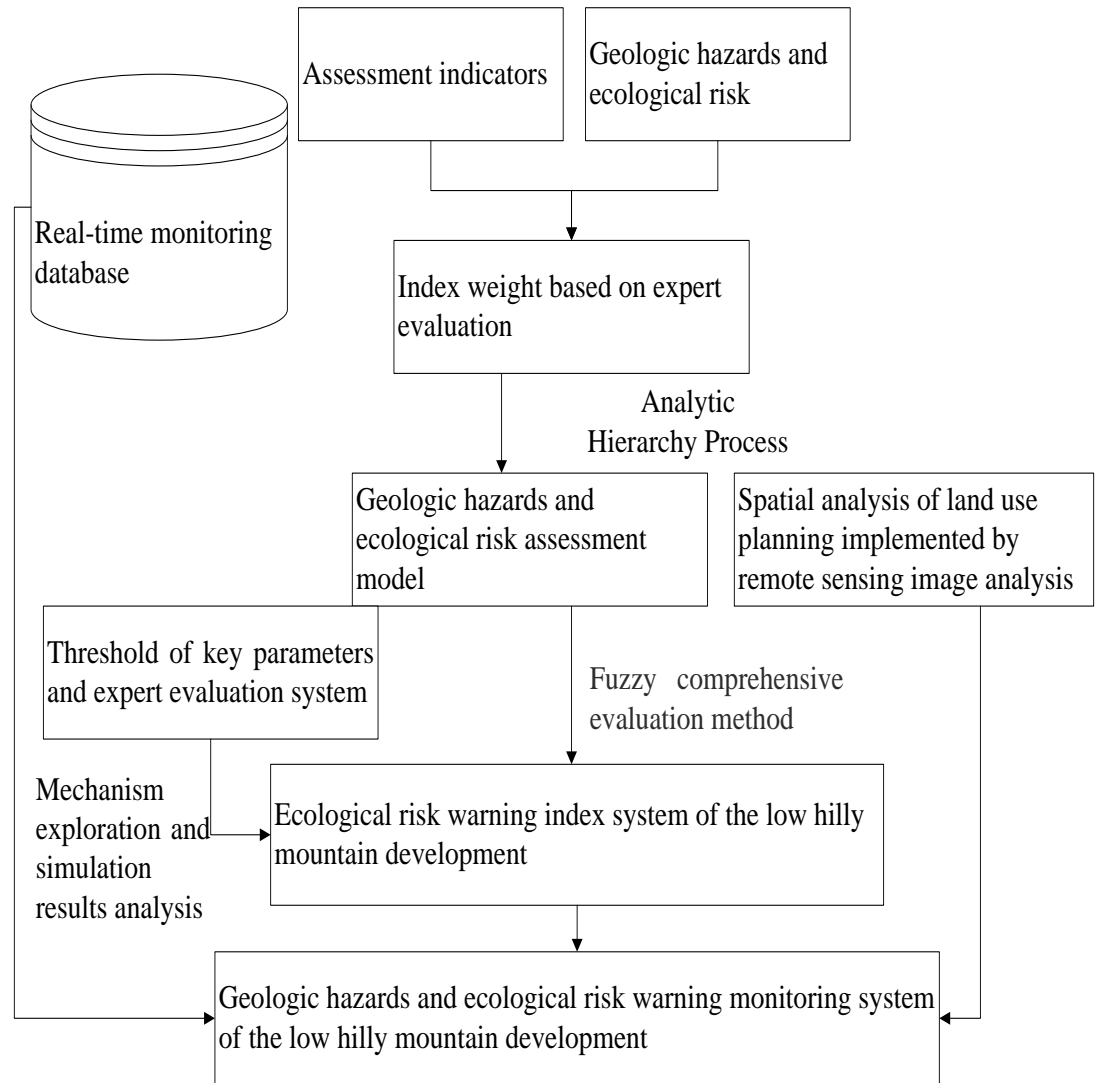
Work package #2



- Select and explore the project area (Low hilly mountain of Dali city)
- Collect meteorological, hydrological, land cover and land use, and topography data to build risk model
- Explore the mechanism of occurrence of geological hazards, prepare parameters for RA(Rockfall Analyst) simulation, launch geological disaster process simulation

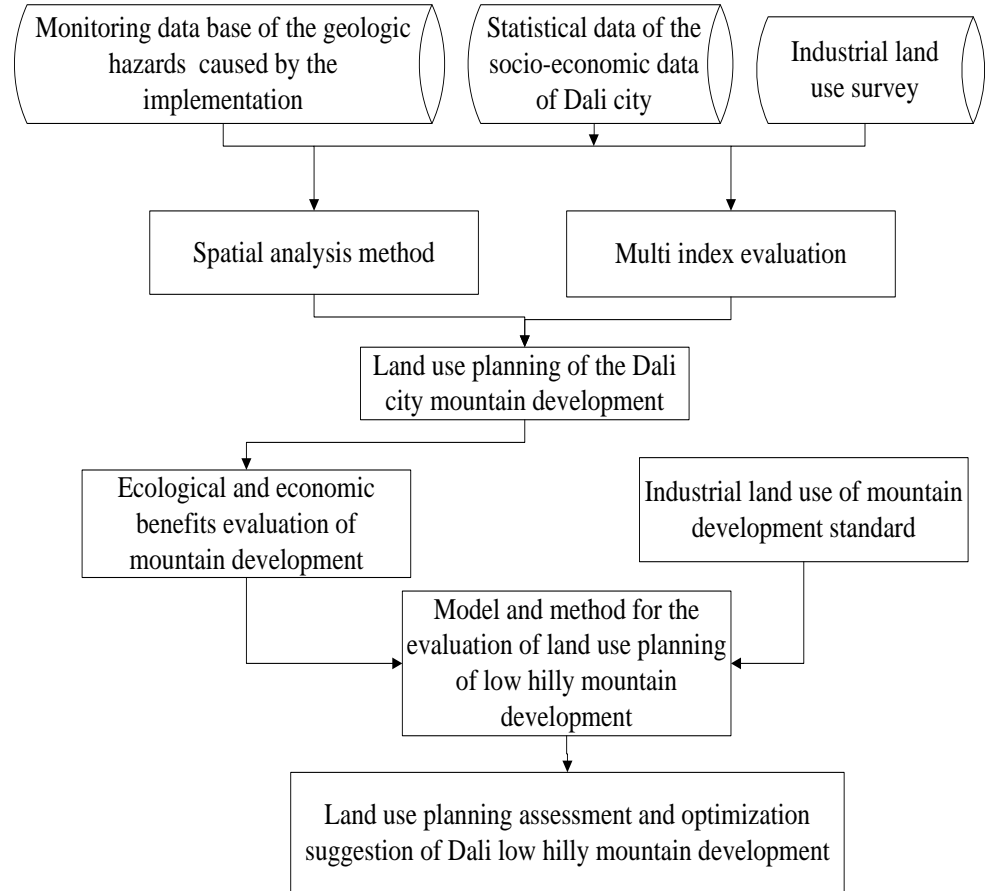
Work package #3

- Research on remote sensing image analysis algorithm, build extraction technique based on high resolution remote sensing image
- Determine warning threshold of key index of natural disasters and agricultural risks
- Develop warning and monitoring system of **natural disaster risk and agricultural development**



Work package #4

- Select the constrain index of ecological sustainability, quantize the standard of **land use planning and agricultural land use**
- Research on evaluation model and technical method of implementation of **land use planning and natural resource management**
- Evaluate the implementation effect comprehensively, provide regulating measures and suggestions for **the optimization of land use**



Work package #5

- Selection and monitoring key parameters of land use planning for **natural disaster relief and agricultural development**
- **Natural disaster relief and agricultural development** for the region with low mountains and hills of mild slope
- Thresholds of key parameters of **natural disaster relief and agricultural development** in the region with low mountains and hills of mild slope
- Land use planning and risk assessment in mountainous area and regional **optimal land use planning and measurement**

ECONOMIC EVOLUTION IN CHINA ECOLOGICALLY FRAGILE REGIONS

Xiangzheng Deng*

Chinese Academy of Sciences

JOURNAL OF CLEANER PRODUCTION, 2016
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http://dx.doi.org/10.1016/j.jclepro.2016.1241312



A review on historical trajectories and spatially explicit scenarios
of land-use and land-cover changes in China

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Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro



Relationship between landscape diversity and crop production: a case

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Quantitative measurements of the interaction between net primary
productivity and livestock production in Qinghai Province based on

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Journal of Cleaner Production

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Management of trade-offs between cultivated land conversions and
land productivity in Shandong Province



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^dSchool of Business Administration, Zhongnan University of Economics and Law, Wuhan, 430073, China

Deng, X., J. Gibson, P. Wang, 2017. Relationship between landscape diversity and crop production: a case study in the Hebei Province of China based on multi-source data integration, *Journal of Cleaner Production*, Volume 142, Part 2, 985-992.

Deng, X., J. Gibson, P. Wang, 2017. Management of trade-offs between cultivated land conversions and land productivity in Shandong Province, *Journal of Cleaner Production*, Volume 142, Part 2, Pages 767-774.

Deng, X., J. Gibson, P. Wang, 2017. Quantitative measurements of the interaction between net primary productivity and livestock production in Qinghai Province based on data fusion technique, *Journal of Cleaner Production*, Volume 142, Part 2, Pages 758-766.

Deng, X., Z. Wang, C. Zhao, 2016. Economic Evolution in China Ecologically Fragile Regions. 2016. *Journal of Economic Surveys*, 30(3): 552-576.

Deng, X., Z. Li, J. Gibson, 2016. A review on trade-off analysis of ecosystem services for sustainable land-use management, *Journal of Geographical Sciences*, 26(7): 953-968.

Deng, X., J. Huang, S. Rozelle, et al., 2015. Impact of urbanization on cultivated land changes in China. *Land Use Policy*. 45, 1-7.

Deng, X., X. Bai, 2014. Sustainable urbanization in western China, *Environment*, 56(3): 12-24.

.....

Patent certification and software developed

- Computable General Equilibrium on Land Use Change (CGELUC) model
- Dynamics of Land System(DLS) model
- System Dynamics of Land Use Changes(SDLUC) model
- Areal Sampling Toolset (AST) Software
- estimation system for agricultural productivity(ESAP) model
- Spatial extrapolation Toolset (SET) software



Policy briefs and awards

Applications endorsed more than ten times, Research awarded by prizes twice

中国科学院


中国科学院政务信息采用通知

地理科学与资源研究所:

你单位于 2008年5月28日 向办公厅信息宣传处报送的信息 中科院专家关于汶川地震灾害对全国粮食和猪肉价格的影响分析, 被院办公厅刊物 《中国科学院专报信息》2008年第169期 采用, 并上报 中办 和 国办, 已被 中办 刊物 《信息综合专报》 采用。

感谢贵单位对我们工作的大力支持, 希望继续关注和支持我院的政务信息工作, 及时将本单位的科研成果、发展动态以及针对我院和国家的重要建议等重要信息报送办公厅, 为国家发展和我院的知识创新工作做出更大贡献。

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二〇〇八年五月二十九日

中国科学院


中国科学院政务信息采用通知

地理科学与资源研究所:

你单位于 2010年4月23日 向办公厅信息宣传处报送的信息 中科院专家关于青海玉树地震对灾区粮食与畜产品价格波动及农牧业生产影响的分析, 被院办公厅刊物 《中国科学院专报信息》2010年第58期 采用, 并上报 中办 和 国务院抗震救灾总指挥部, 已被 中办 刊物 《专报》 采用, 并得到 四友玉副总理 批示。

感谢贵单位对我们工作的大力支持, 希望继续关注和支持我院的政务信息工作, 及时将本单位的科研成果、发展动态以及针对我院和国家的重要建议等重要信息报送办公厅, 为国家发展和我院的知识创新工作做出更大贡献。

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二〇一〇年五月三十一日

证书

为表彰在促进科学技术进步工作中做出突出贡献者, 特颁发海南省科学技术奖证书, 以资鼓励。

获奖项目: 海南省土地利用系统评估与优化决策技术
获奖者: 邓祥征
(第七完成人)
奖励等级: 一等奖
证书号: 2009-01-058
奖励日期: 二〇〇九年五月



中国水产科学研究院
科技进步奖
奖励证书

为表彰中国水产科学研究院科技进步奖获得者, 特颁发证书, 并授予“中国水产科学研究院-魏子禹渔业科技进步奖励基金”奖励。

成果名称: 对虾养殖管理信息系统研究与建立

获奖等级: 三等奖
获奖者: 邓祥征(第3完成人)


二〇一〇年五月二十九日

证书编号: 2011-3-05-003

Applications for decision makings at all levels

云南财经大学
YUNNAN UNIVERSITY OF FINANCE AND ECONOMICS

地址：云南省昆明市学府路127号
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关于继续加强针对土地利用优化模型能力建设的需求说明

模型研发组：

云南省高校高原山地土地利用重点实验室在系统研究高原山地土地利用理论与技术方法，通过建成高原山地土地利用决策支持系统，为云南高原山地土地可持续利用提供科学依据和决策支持，为构建符合我国高原山地实际的土地利用管理理论、技术方法和制度设计及其山区经济建设与社会发展做出贡献。

作为实验室建设的一项核心技术支撑的土地系统动态（GLS）模型与土地利用优化均衡（OELUC）模型目前已经部署到重点实验室的硬件环境中，通过对土地利用调查数据的精细化管理，实现了对全省土地利用空间数据和属性数据的一体化管理，促进了土地资源数据管理、分析与处理的规范化，并实现了基于不同土地利用方案输出各种政策调控手段与利用效果前瞻图，为有效发挥高原山地土地利用管理的宏观调控发挥了重要决策支持功能。

重点实验室结合GLS模型与OELUC模型的特点充分发挥这两个模型的决策支持功能，分别建成土地利用仿真研究室与土地利用决策支持系统研究室，以研究室建设为牵引，开发好、利用好模型的决策支持功能，通过开展土地利用数据库建设、模型开发和土地利用决策支持系统相关技术等科学研究，辅助国土资源部门开展优化土地利用的科学决策实验。鉴于此，希望模型研发组继续针对重点实验室土地利用优化模型能力建设方面提供技术支持，谢谢。

云南省高校高原山地土地利用重点实验室
云南财经大学城市与环境学院（代章）

与变化均衡分析系统（CGELUC）与区域用地结构（UC）”支持了国家973项目“研究”的应用证明

CGELUC/SDLUC 推广应用证明

在973课题“集水区入湖生态”重要的工具软件，在集水区得到了应用与验证，并为该数据资料，CGELUC/SDLUC

“调查技术导则”中作为辅助

推广应用单位

公章：

日期：

开发完成的“土地系统动态规划的应用证明

软件基本信息	编号： 软件著作权登记号： 2007SR 软件名称： 土地 著作权人： 中国科 首次发表日期： 2007年
软件用途及效果	主要用于： ① 辨识影响北京经济因素； ② 揭示北京市变化的机制； ③ 评估北京市密2 ④ 开展北京市密2 ⑤ 输出北京市密2
使用证明	该软件能够很好地管理、景观规划与保护具有强时效针对性，过程与结果，揭示了当及其他生态环境的影响，格局变化系列图件，《2005-2020》”提供了
推广应用单位	中国环境科学研究院
公章：	
日期：	

开发完成的“农业生产潜力监测与评估技术研究”的应用证明

通信地址	北京市朝阳区安外北苑
软件基本信息	编号： 软件著作权登记号： 2007SRB 软件名称： 农业生产 著作权人： 中国科学 首次发表日期： 2007年
软件用途及效果	主要用于： ① 项目区土地适宜性 ② 项目区农业生产 ③ 项目区农业生态 ④ 项目区人口承载
使用证明	该软件能够很好地处理决策的信息需要，模型地模拟出项目区农业生产利用强度、气候资源需求生产力及土地适宜性时变价技术研究”项目提供了
推广应用单位	中国环境科学研究院
公章：	
日期：	2008

河套灌区基于土地利用优化的面源污染控制与管理系统的证明

河套灌区目前灌溉面积近60万hm²，是中国第三大灌区。近几年来，随着灌区工业生产和城镇人口的增加，通过排水系统进入乌梁素海的工业、农业及生活污水每年多达3—5亿立方米，给灌区水体污染控制带来很大挑战。其中作为河套地区山洪和灌溉退水的主要灌区区的乌梁素海的水质管理尤为迫切与突出。

河套灌区基于土地利用优化的面源污染控制与管理系统的证明，结合河套灌区实际的应用需求，以灌区土地利用背景、社会经济与自然环境数据集为基础，耦合了土地利用优化调控、湖泊流域系统管理的理论方法，服务于基于土地利用优化的面源污染控制与管理决策。该系统以计算的湖泊营养物容量为目标约束值，从水质与水量综合角度建立了流域土地利用调控与资源-环境-经济系统的动力学模型，实现了多情景核算流域承载力变化的方案模拟。

目前，该管理系统已在我灌域开展了很好的的应用。管理系统结合乌梁素河流域的排水系统的现状与流域土地利用强度，置入了面源管理的BMP策略实例，基于数据络分析综合评价输入方案数据和模型结果，为确立最优的氮、磷削减和经济协调发展方案提供了依据。该系统已经形成了目标-过程-模拟-决策为一体的湖泊营养物氮、磷营养盐削减技术集成体系，为优化灌区土地利用决策以控制面源污染并实现绿色流域建设中提供了重要的决策支持。

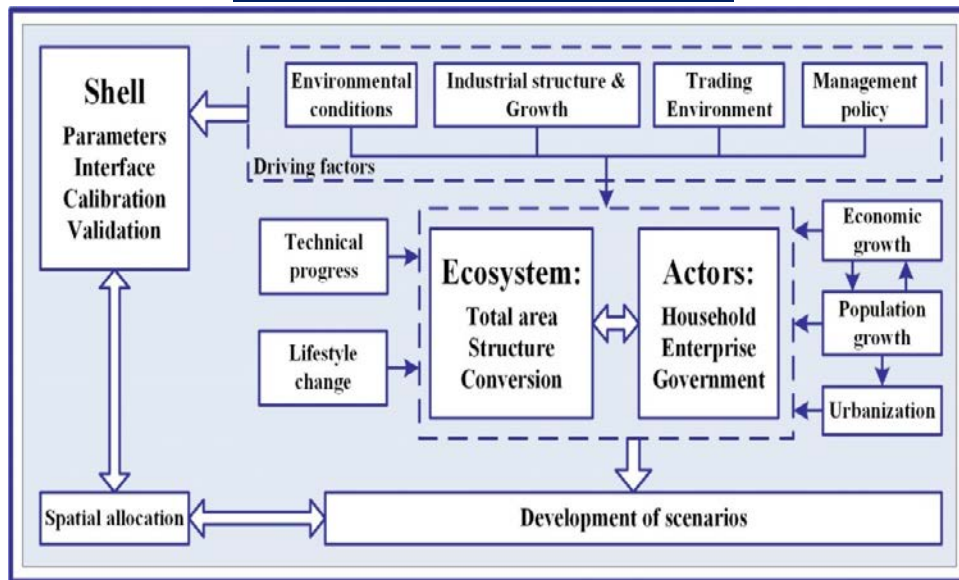


Outline of this talk

- Background
- Framework
- An application
- Development prospect

Promising applications for environmental protection and sustainable development for nations/regions

Data Integration



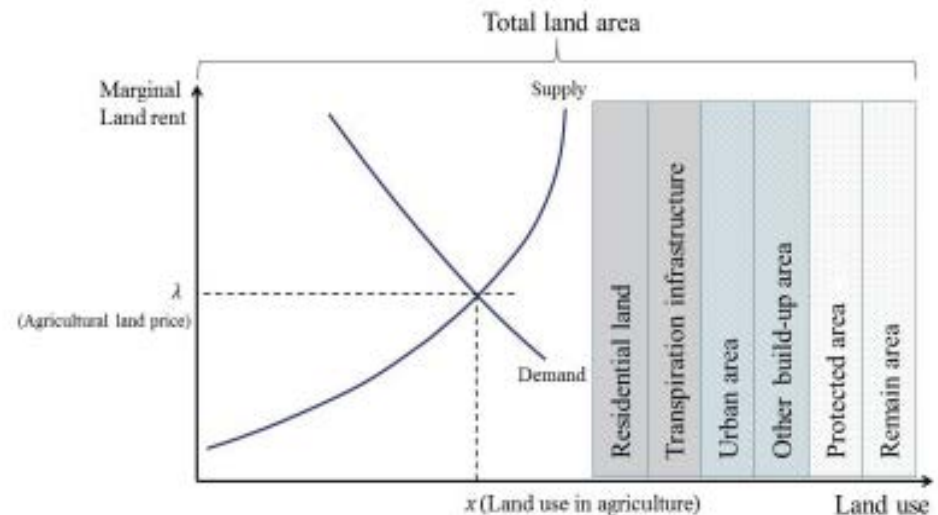
- Natural resources pattern
- Economic pattern
- Tourism industrial pattern
- Ecological civilization mode
- Regional economic integration mode
- Transportation economic belt mode
- Development mode of international tourism economic zone
- Technology cultural cooperation

Identification of the Interactions between **REE** (Resource, Ecology and Environment) & **D** (Development) referring to the Platform

Promising applications for environmental protection and sustainable development for nations/regions

Estimation of parameters

- The evolution and driving forces **of landscape of nations/regions**
- The spatial patterns and the **interactive mechanism of agriculture and nature resource management** of nations/regions

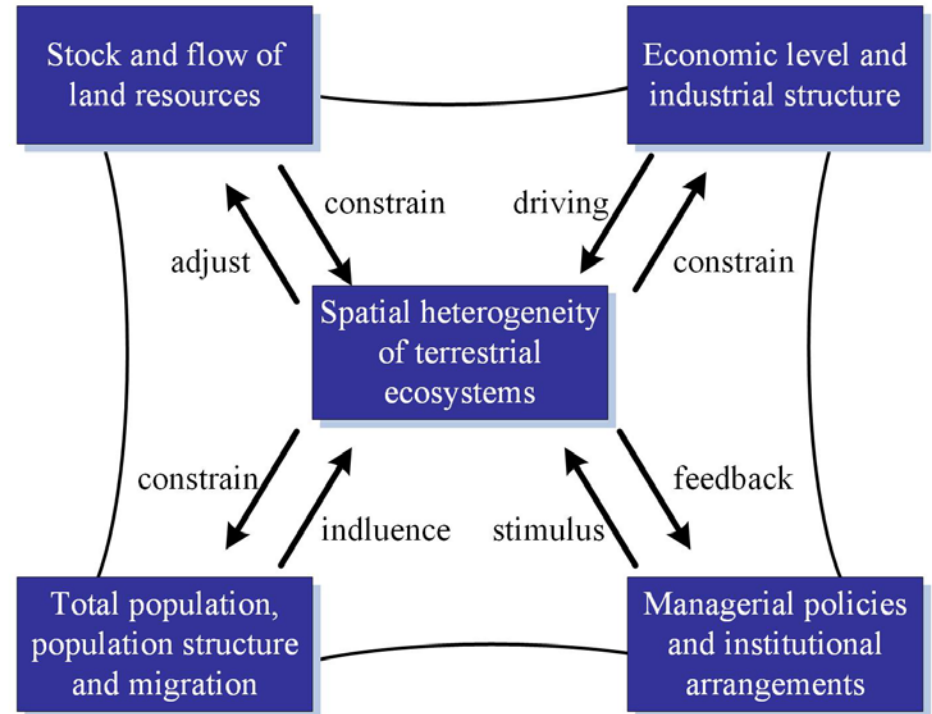


Investigating and handling the conflicts between development and conservation referring to the Platform

Promising applications for the environmental protection and sustainable development for nations/regions

Scenario designs

- Status of **economic integration**
- Strategic directions for the formation of **ecology-oriented investment policy** on the territories with environmental
- Strategy of the **balanced regional development in conditions of natural limitations**
- International cooperation for **scientific data sharing** in the Trans — boundary basin of lake Baikal

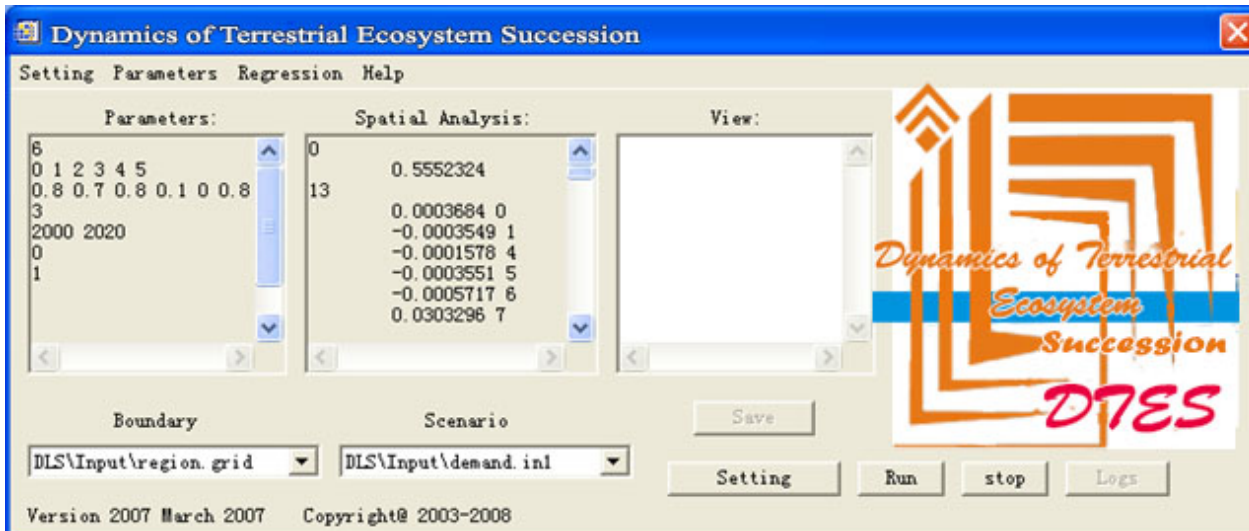


Scenarios designs considering the enablers as well as constrain for both natural conservation and regional development

Promising applications for the environmental protection and sustainable development for nations/regions

Decision-making Support System

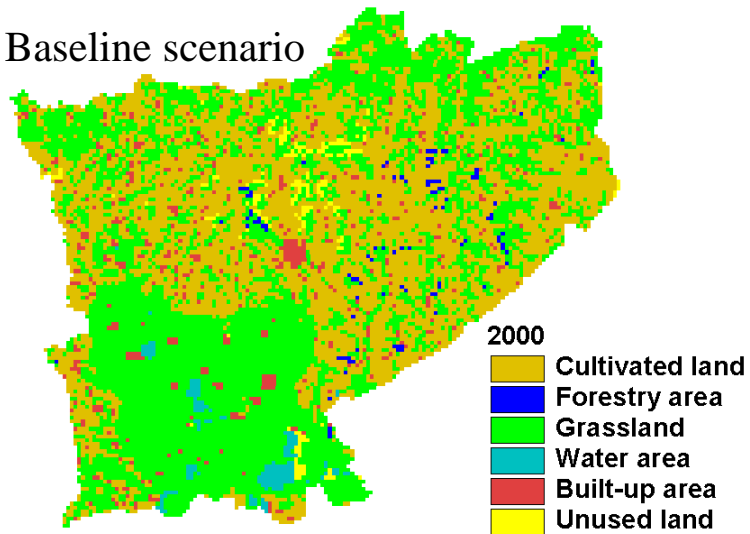
- Assessment of resource and environment carrying capacity and ecological service functions of nations/regions around the **sustainable development of agriculture**.
- Strategy of the **balanced regional development in conditions of natural limitations**



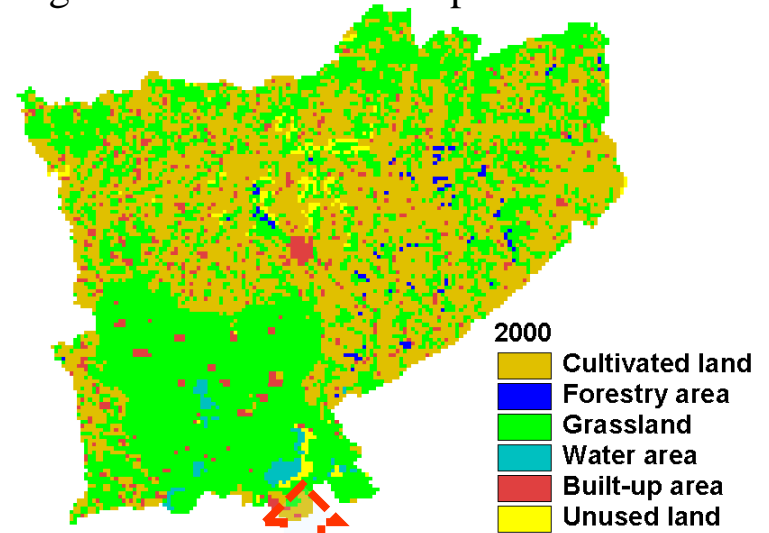
Software toolset specifically developed for tracing the COOKED or VALVED pressures with enhanced development referring to the Platform

Demonstrations of the spatially explicit outcomes

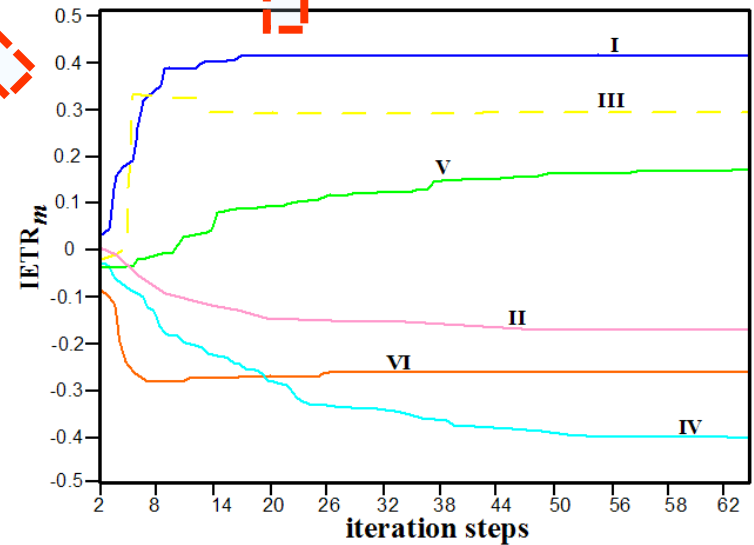
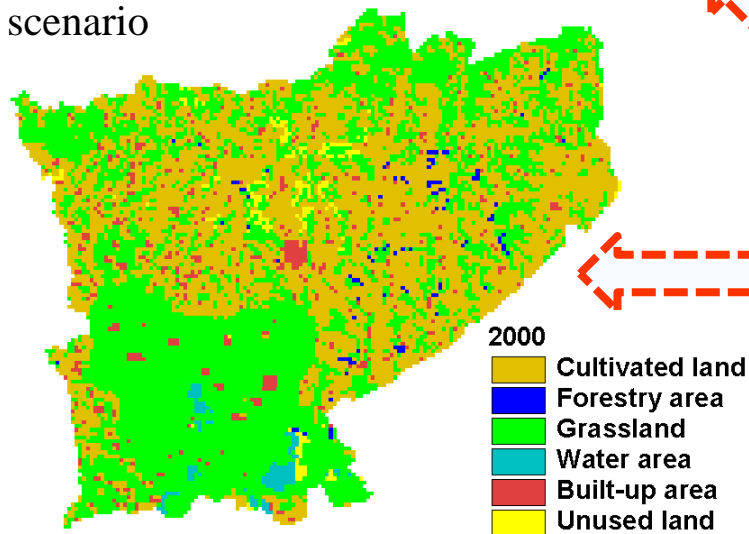
Baseline scenario



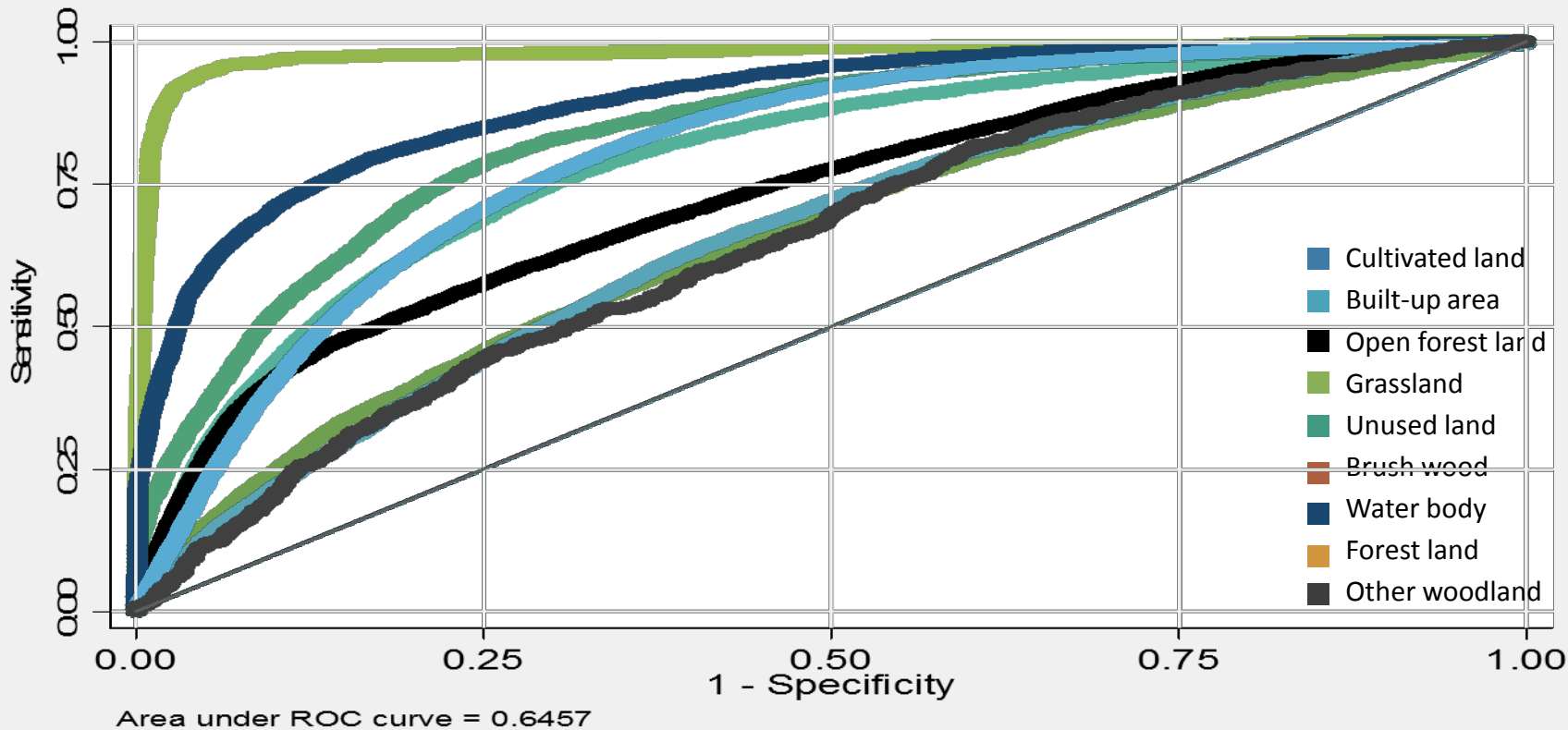
Fragile area restrict development scenario



Regional differentiated development scenario



Validation and Calibrations



		Predicted value		Judgment accuracy
		0	1	
Observed land		0	1	
Other woodland	0	0	0	100
	1	785	166074	99.53
Total				99.76

Concluding remarks...

- This kind of Platform is capable of offering spatial explicitly decision support information for achieving the Win-Win objectives **of both agriculture and natural resource management.**
- There is an urgent need to integrate geophysical process into the socio-economic development, or vice versa, in this kind of Platform which facilitates the so called *Science Informs Policy*;
- **Prioritized research themes** on the **agricultural and natural resource management** would be enhanced by developing and using this kind of Platform via, last but the least, the data integration, estimation of parameters, scenario designs, **DSS** developments referring to this kind of Platform.....

The most urgent research topics?

- Data, definition and classification
- Specific training on data aggregation and/or disaggregation over space and/or over time
- Capacity building on integrated modelling



Data and Indicators

Spatially Disaggregated Social/Economic Status

- Demographic
- Gross Domestic Product
- Health

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Spatially Interpolated Climate surfaces

- Rainfall
- Air temperature
- Humidity

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Sector-based land-use Suitability

- Industrial
- Commercial
- Residential

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Scenario-oriented Land Use/Cover Changes

- Cultivated
- Forest
- Urban

.....

Systematically Surveyed Ecosystem Service/Functions

- Supporting
- Provisioning
- Regulating

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Thanks for your attention!

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