Watershed-based Natural Resource Management in Small-scale Agriculture: Sloped Areas of the Andean Region

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SANREM CRSP

Objectives of Presentation

- Present an overview of our SANREM research project, including objectives, methods, and relationships among research activities
- Give a flavor of some early findings
- Discuss additional activities

Host-Country Partners

- **Ecuador:** INIAP—Victor Barrera, Elena Cruz, Franklin Valverde; ECOCIENCIA—Adriana Cardenas, Juan Calles; SIGAGRO-MAG—Juan Carlos Montufar; ECOPAR—Kelvin Cuevas
- **Bolivia:** PROINPA—Ruben Botello, Ilich Figueroa, Nadezda Amaya, Norka Ojeda, Giovanna Plata, Javier Franco, Gladys Main; PROMIC—Omar Vargas, Ana Karina Saavedra; UMSS --Susana Arrazola ; CERES—Jean-Paul Benavides, Harry Soria Galvarro
- **CIP:** Javier Osorio

Instituto Nacional Autónomo de Investigaciones Agropecuarias Ecuador

US Partners

- Jeffrey Alwang Ag. and Applied Economics, Virginia Tech
- Darrell Bosch, Ag. and Applied Economics, Virginia Tech
- George W. Norton Ag. and Applied Economics, Virginia Tech
- Sarah Hamilton, International Development, Univ. of Denver
- Mary Leigh Wolfe, Bio. Systems Engineering, Virginia Tech.
- Brian Benham, Center for TMDL and Watershed Studies, Bio. Systems Engineering, Virginia Tech
- Conrad Heatwole, Bio. Systems Engineering, Virginia Tech
- Paul Backman, Plant Pathology and Biocontrol, Penn State
- Jonathan Lynch, Plant Nutrition, Penn State University
- Wills Flowers, Entomology and Biological Control, Florida A&M

Project Objectives

Overall goal: Enable and support local capacity to plan policies and interventions to raise incomes, improve social conditions and protect and improve the environment in Guaranda, Ecuador and Tiraque, Bolivia.

- Identify economic, social, political and environmental conditions in the watersheds and understand the determinants of these conditions.
- Generate and validate environmentally sustainable alternatives to improve production systems and enhance income generation.
- Create a means of evaluating the impacts of alternative actions, policies and interventions on income generation, and social and environmental conditions
- Build local capacity to evaluate policy alternatives, make and enforce decisions, and strengthen social capital

Organizing Concept

- The main organizing instrument of the project is an adaptive watershed management approach whereby local actors are brought together to examine how human activities within the watershed contribute to environmental degradation, and how management alternatives will affect this degradation

Research Activities

- Bio-physical research activities to identify potential solutions to constraints faced by watershed farmers, including plant diseases, variety selection and testing, feasibility of alternative varieties, soil erosion and means of mitigation
- Social science-based research on the determinants of household livelihood strategies, the profitability of livelihood alternatives, costs and benefits of enhanced natural resource management, and institutional considerations affecting governance

Research Activities

- Tied together through comprehensive physical and social models of the watershed
- Model results will be used in a participatory watershed planning process to inform local decisionmakers about the impacts and consequences of alternative land use plans
- Project is engaged in an ongoing dialogue and participation in different components by local stakeholders to build ownership of the research outputs

Sites: Chimbo, Ecuador & Tiraque, Bolivia

- Ecuador:
  - Western Andean watersheds include the Guaranda, Chimbo, San Miguel and Chillanes cantons and provide between 30 and 40% of the total water into the Guayas River
  - Two distinct ecological regions (high plain and subtropical), and four distinct Holdridge zones (subtropical humid forest, low temperate mountain, temperate mountain and boreal)
  - Range from 300 to 4500 meters in elevation and receive between 500 and 4000 millimeters of annual rainfall

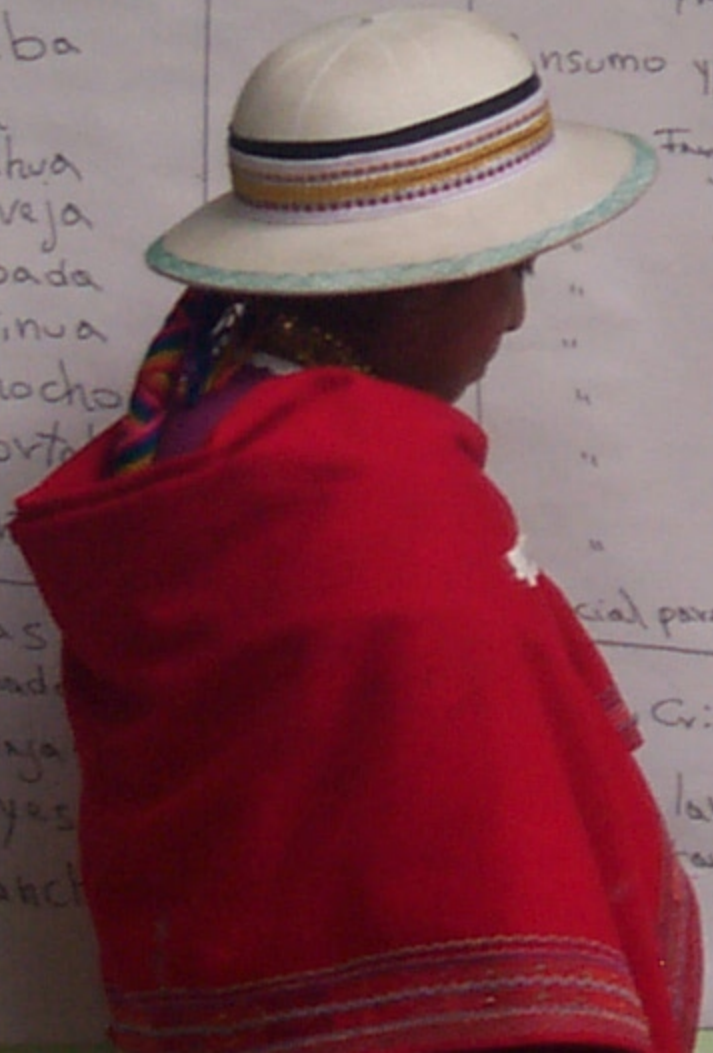
Income Generating Activities

Sub-watershed	Principal income-generating activities
Upper Rio Illangama Alto Guanujo	Agriculture (potatoes, pasture, cereals), livestock (cattle, sheep, pigs, others), tourism, small-scale commerce, handicrafts.
Lower Rio Alumbre Chillanes	Agriculture (maize, beans, peas), livestock, agro-industry (including medicinal plants, cacao and organic coffee), tourism, small-scale commerce, handicrafts.

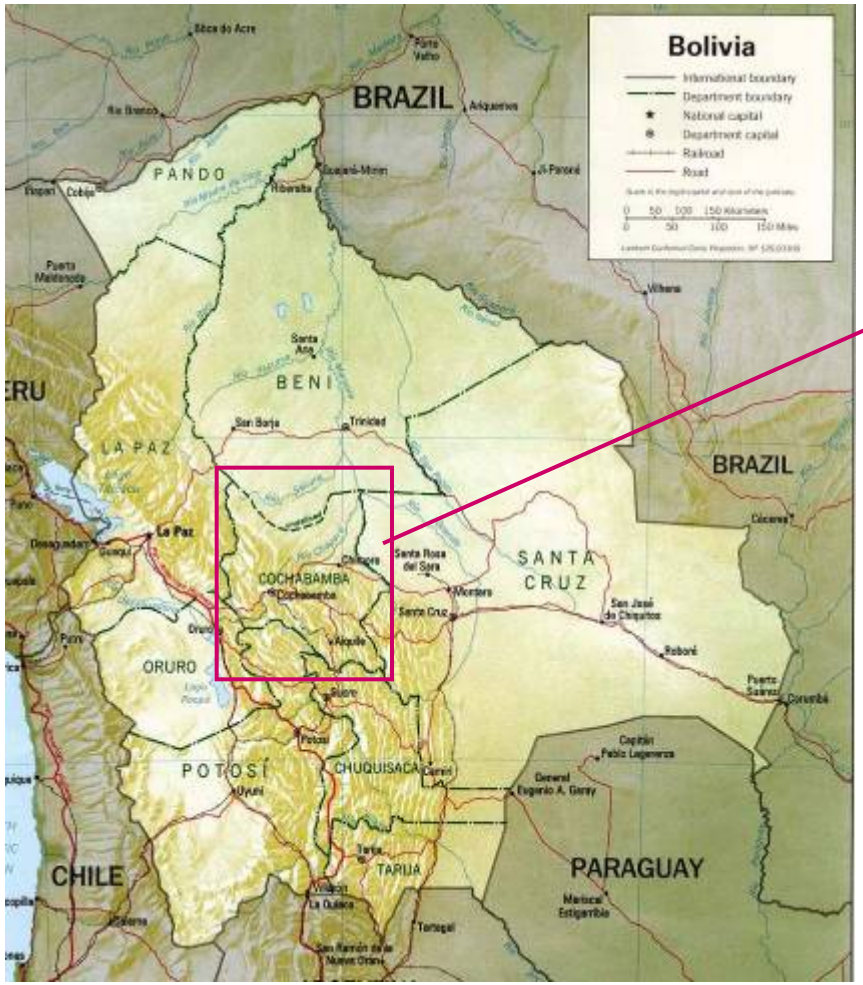
Actividades Productivas Grupo 2÷

tividad	Importancia	Destino producció
ltivos		
- Papa	1	Consumo y Venta
- Haba		nsumo y poco venta
- Oca		Familiar
- Mashua		"
- Arveja		"
- Cebada		"
)- Quinua		"
)- Chocho		"
)- Hortal		"
e)- Plan		"
cuarias		cial para venta
- Ganad		Crias
- Ovinos		lana
- Cuyes		amiliar
Chanch		

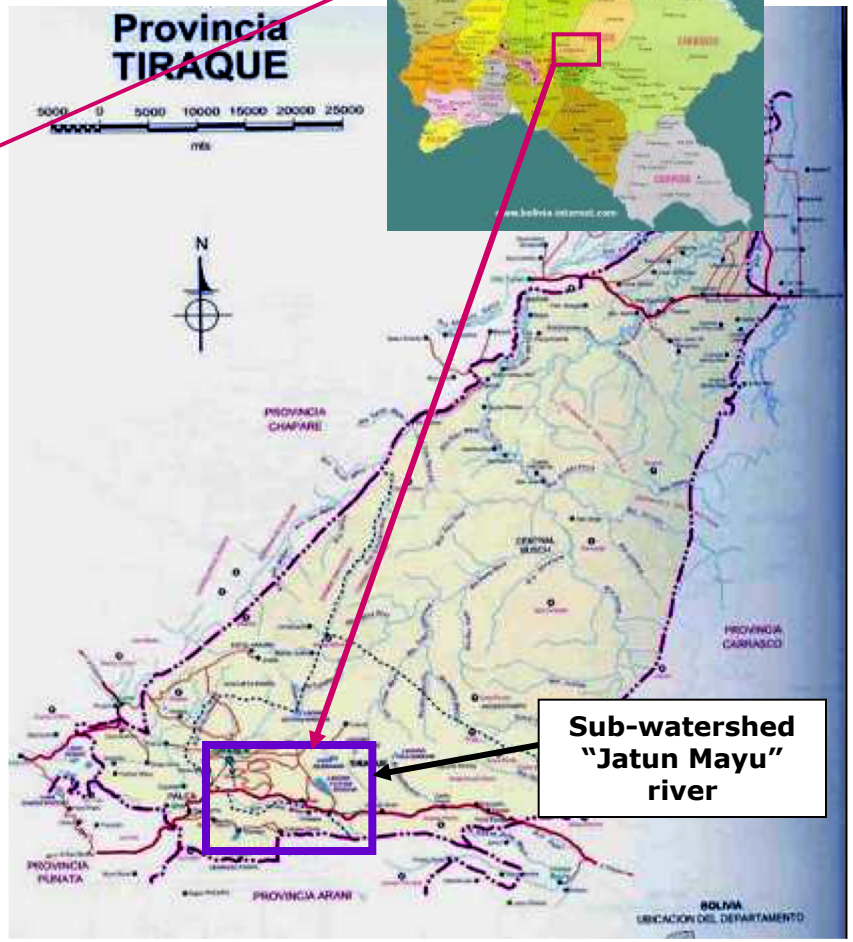
Actividad	Importancia	Destino Prod.
Artesanias		
1 - Ponchos		Consumo y Venta
2.- Bayetas		" "
3 - Gorros		" "
4 - Fajas		" "
5 - Chalinas		" "
6 - Sacos		" "
7 - Cobijas		" "
Recursos Naturales		
1 - Madera		Venta
2 - Leña		Consumo
Otros		
1. Migracion		
2.- Minga comunal		



Bolivia: Sub-watershed location



Departament of Cochabamba



Bolivia Site

- Located in southern Tiraque Province, 70 Km from Cochabamba
- Between 3000 and 4200 masl, with slopes between 10 and 25% in areas under cultivation and between 20 and 40% in pastured areas.
- Comprised of 14 communities, with a population of approximately 3,000
- The area is semi humid, with approximately 550 mm of annual rainfall, and cold climate

Bolivia Site: 3 Zones

Lower zone	Middle zone	Higher zone
3000 - 3200 (masl)	3000 - 3200 (masl)	3800 - 4300 (masl)
Characteristics: 2 communities Intensive agriculture in rain season and under irrigation	Characteristics: 10 communities Agriculture in rain season and under irrigation	Characteristics: 2 communities Agriculture only in rain season. Low temperatures
Main crops		
Potato, faba bean, pea, maize, wheat, barley, oat, quinoa grain & vegetables	Potato, faba bean, barley, oat, pea, oca tuber & some vegetables	Potato, faba bean and potato seed in higher places.


SANREM CRSP
Delimintación de la
Sub-cuenca Jatun Mayu
Tiraque
Sanki'ayani
Alto
ZONA
ALTA
Kewiña
Khocha
Lushikha
Khocha
Kuri
Khocha
Laguna
Jatora Khocha
Pueblo Viejo
Puyqo
Mayu
Uchuchi
Cancha
Waylla
Pujru
Waca
Wasi
Tiraqueña Baja
ZONA
BAJA
Ch'aki
Khocha
Boquerón
Alto
E.E. Toralapa
Toralapa
Alto
Caña Cota
Cebada
Jich'ana
ZONA MEDIA
1ro. de
Marzo
Damy
Rancho
Boquerón
Grande
Suraj
Mayu
Chaupi
Rancho

Research Highlights

(i) Completion of UG internship program: studies of dairy market, drinking water quality, costs of soil conservation investments

(ii) Study of determinants of livelihood strategies and impacts on household well-being near completion

(iii) Assessment of risk and its impact on farmer decisions in Ecuador and on potato variety choice in Bolivia

(iv) Biodiversity assessment completed in Bolivia

(v) Identification of two high-potential crop alternatives for Bolivian highland

(vi) Continuation of a number of agronomic research activities

Biodiversity assessment in Bolivia





Research Activities: Bolivia

- Baseline survey completed. Descriptive publication in final stages
- Data collection to analyze social networks and market chains

- Six flow monitoring stations to determine hydrologic balances
- Six weather monitoring stations established

Agronomic Research in Bolivia

Maca root

Possibility for production of kañawa grain in the middle zone supports food security (high nutritional value)

Farmers from the upper zone empowered in the production of a new and profitable crop.

Kañawa grain

Modeling Activities 2007-08

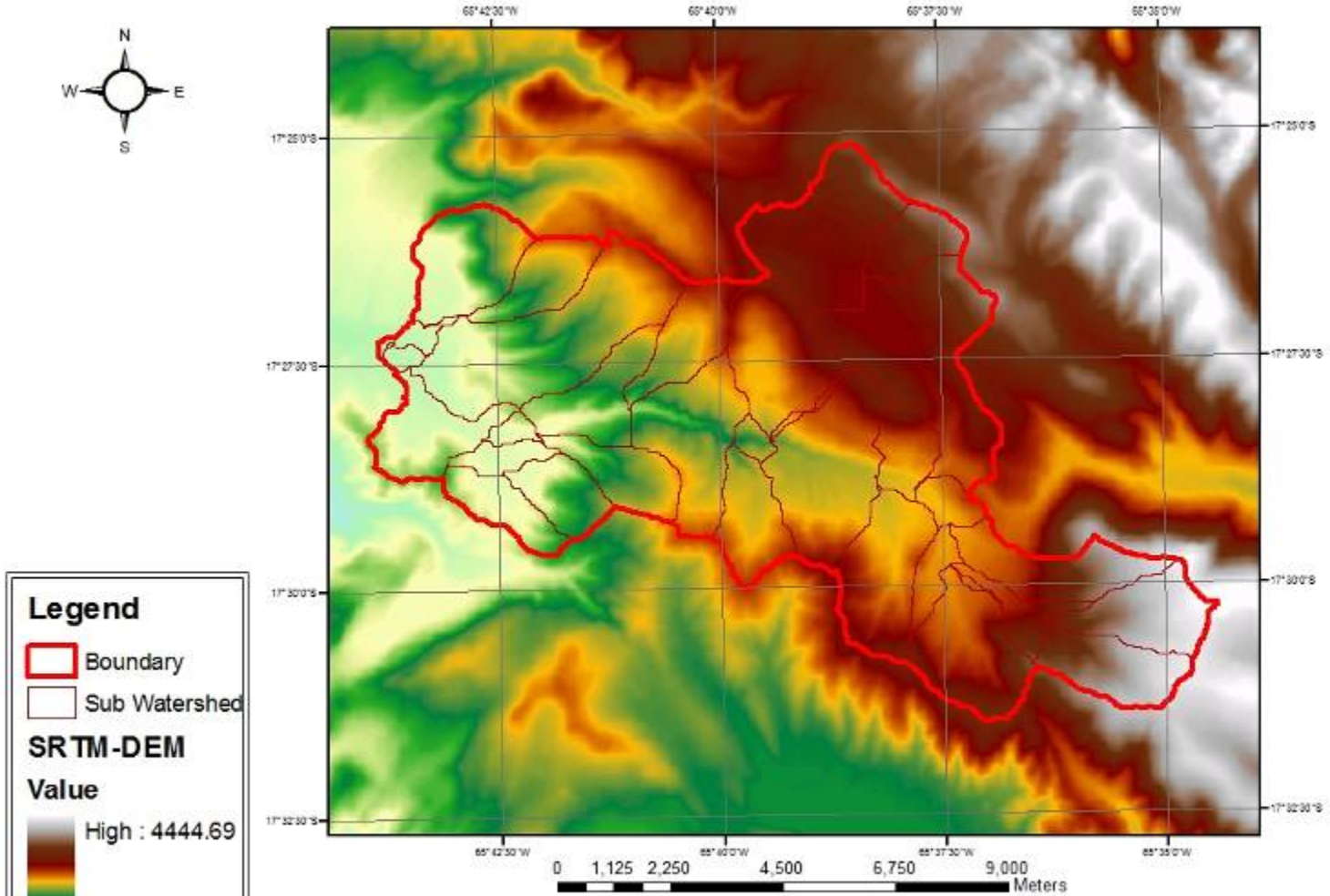
- Month-long modeling workshop conducted at Virginia Tech for three trainees from Ecuador and Bolivia
  - Modeling concepts
  - Hands-on modeling experience
  - Watershed management workshop and meetings

Modeling Activities 2007-08

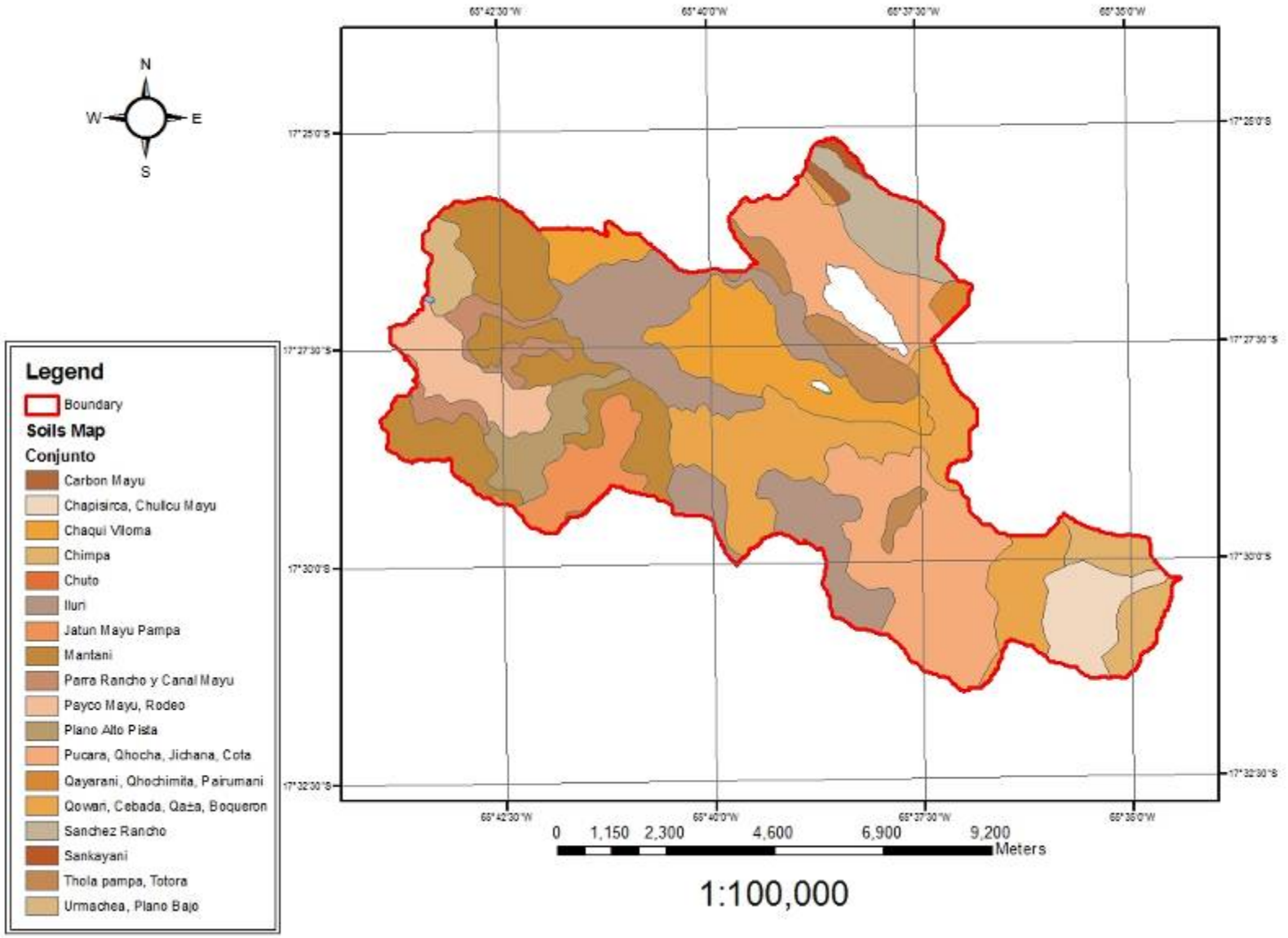
- Assembled GIS data layers for watersheds in Ecuador and Bolivia
  - Digital elevation models (DEMs) obtained and additional analysis done
  - Soils – current data in place; in both watersheds additional soils mapping and descriptions are being developed by in-country partners
  - Landuse – satellite images obtained and classified; additional work being done to refine classifications
  - Weather data – have 14 years of daily data from Bolivian watershed; available for purchase for Ecuador
- Applied SWAT model to Bolivian watershed

Tiraque Province, Cochabamba, Bolivia

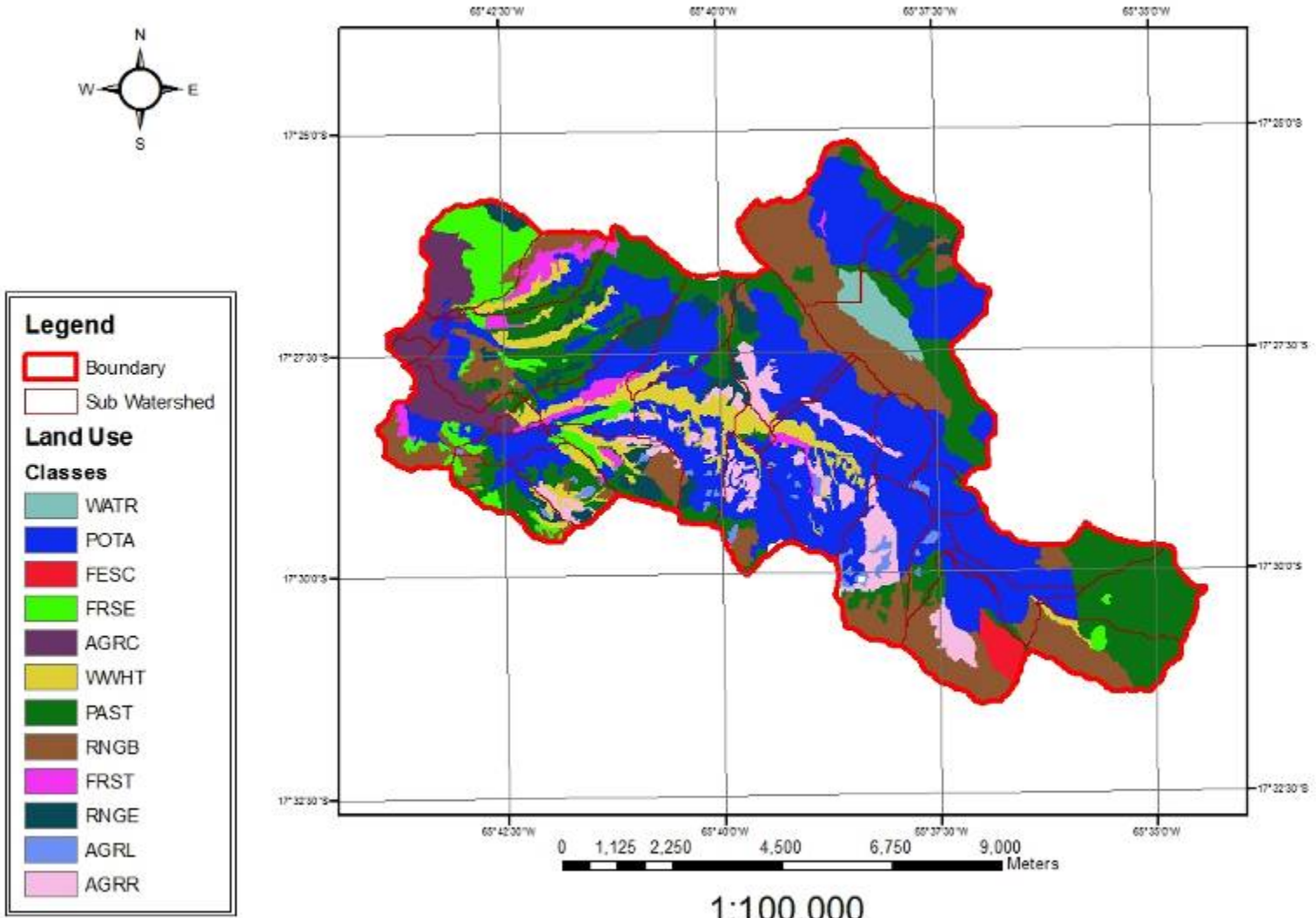
SRTM - 30 m resolution Digital Elevation Model for the Jatun Mayu River Watershed



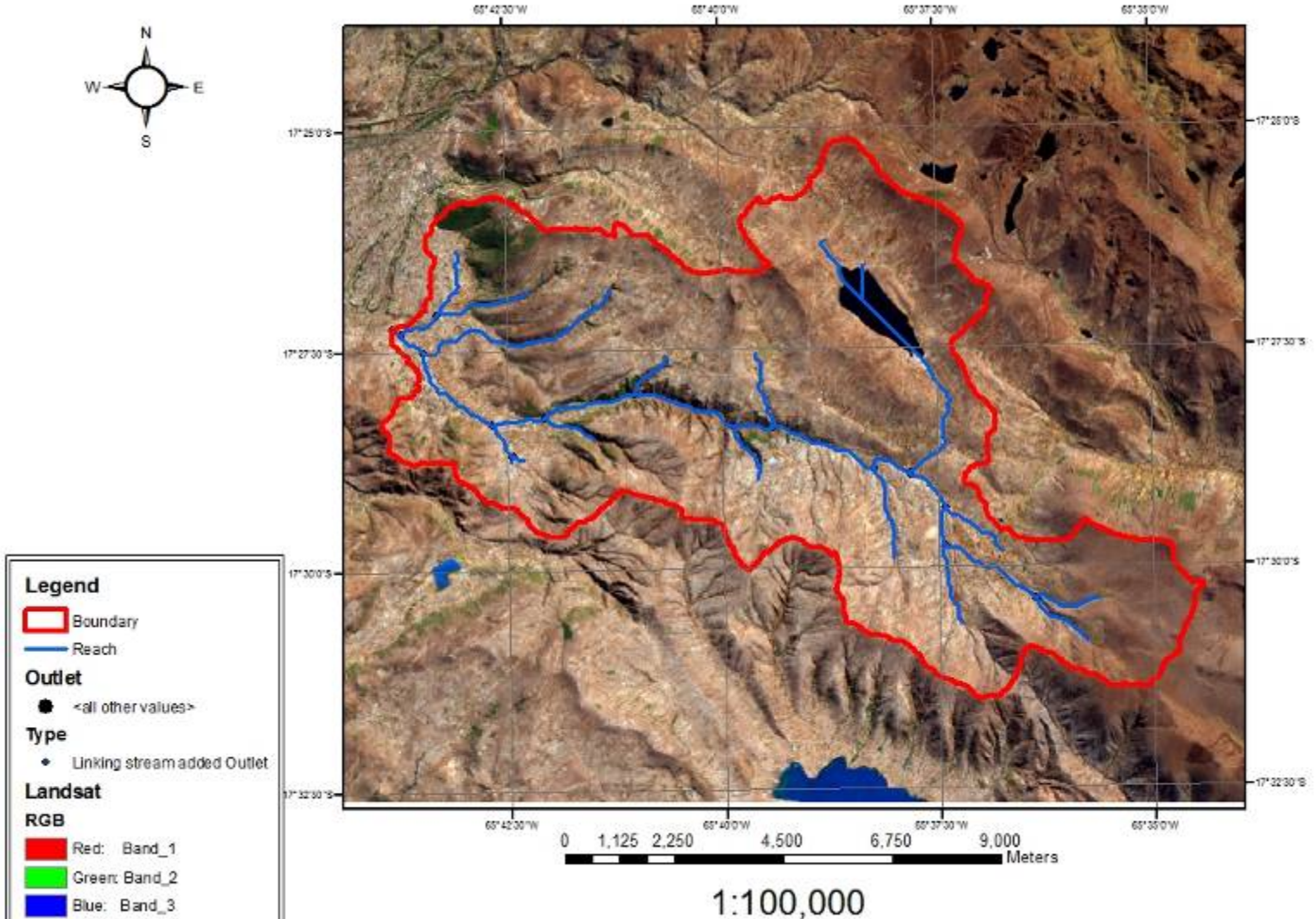
Soils map for the Jatun Mayu River Watershed



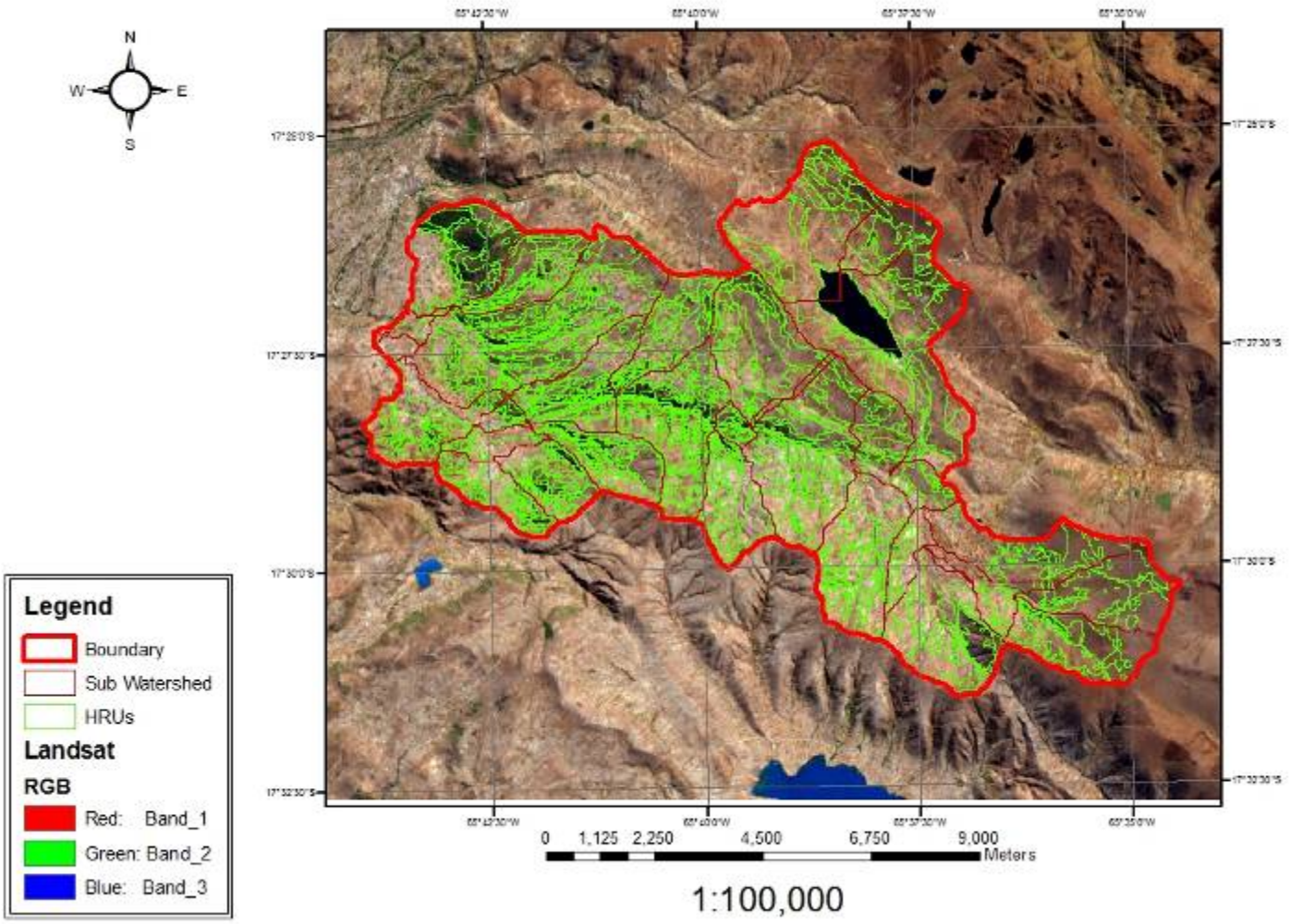
Land use map for the Jatun Mayu River Watershed



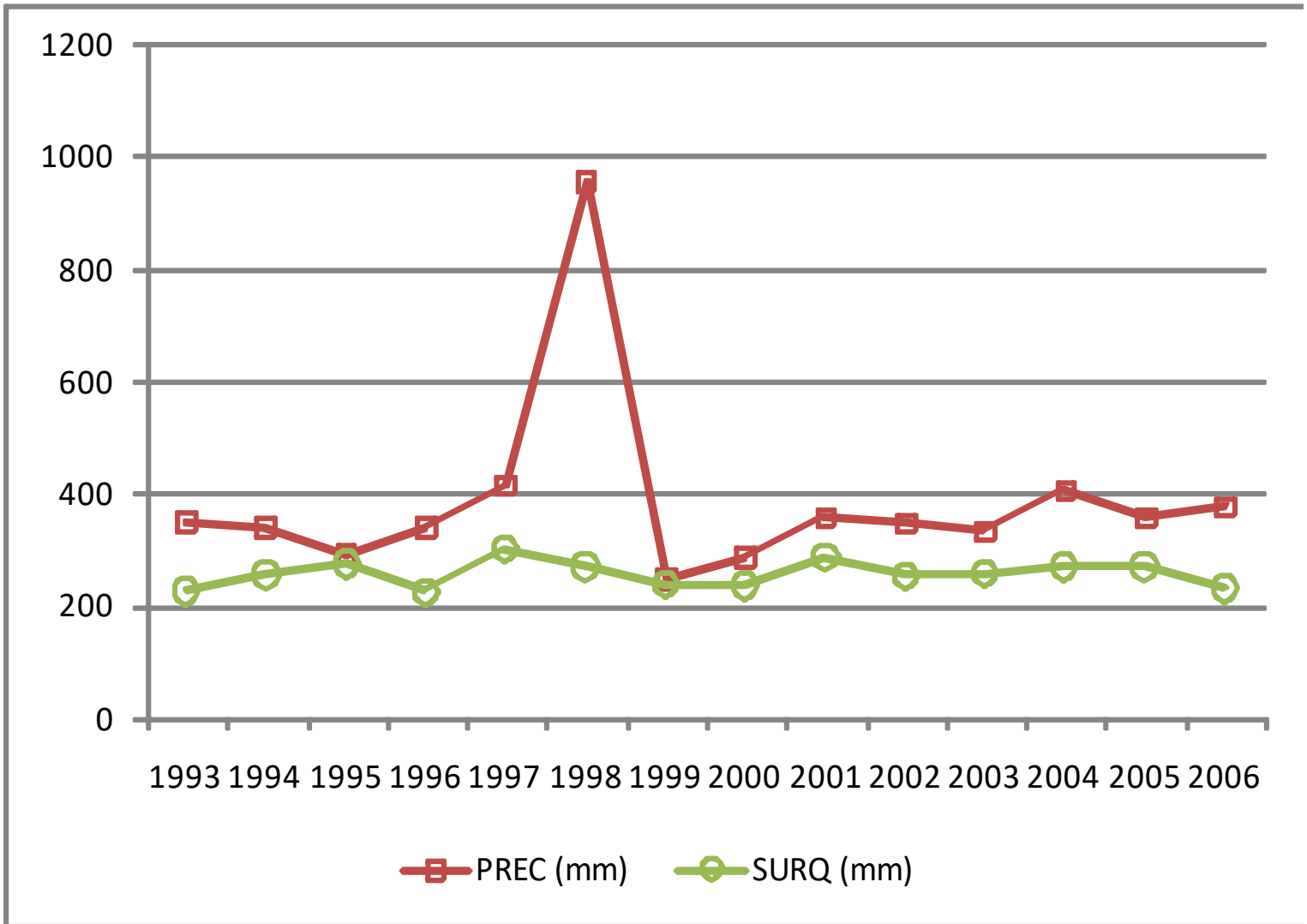
Stream network over a LANDSAT image of the Jatun Mayu River Watershed



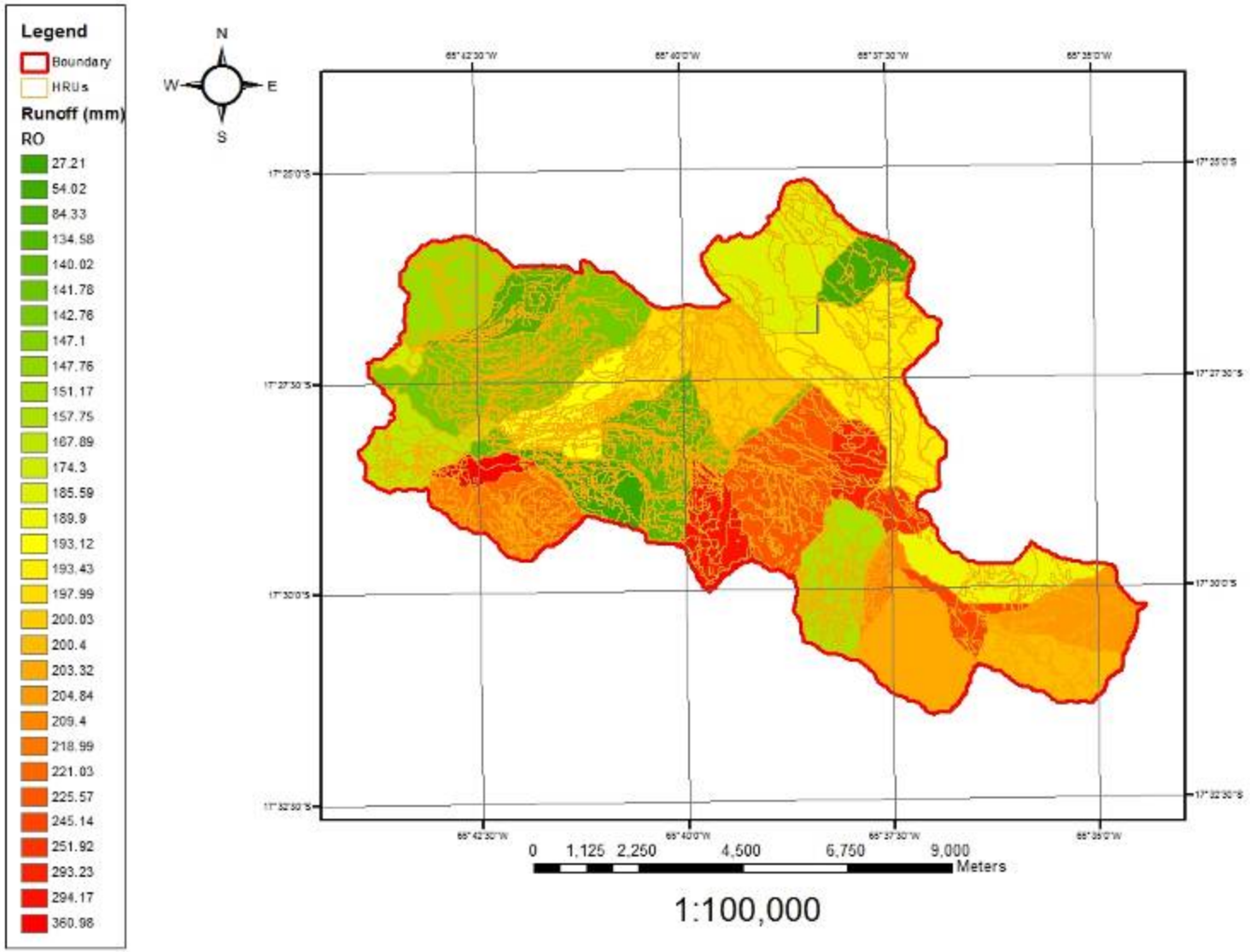
Subwatersheds and HRUs over a LANDSAT image of the Jatun Mayu River Watershed



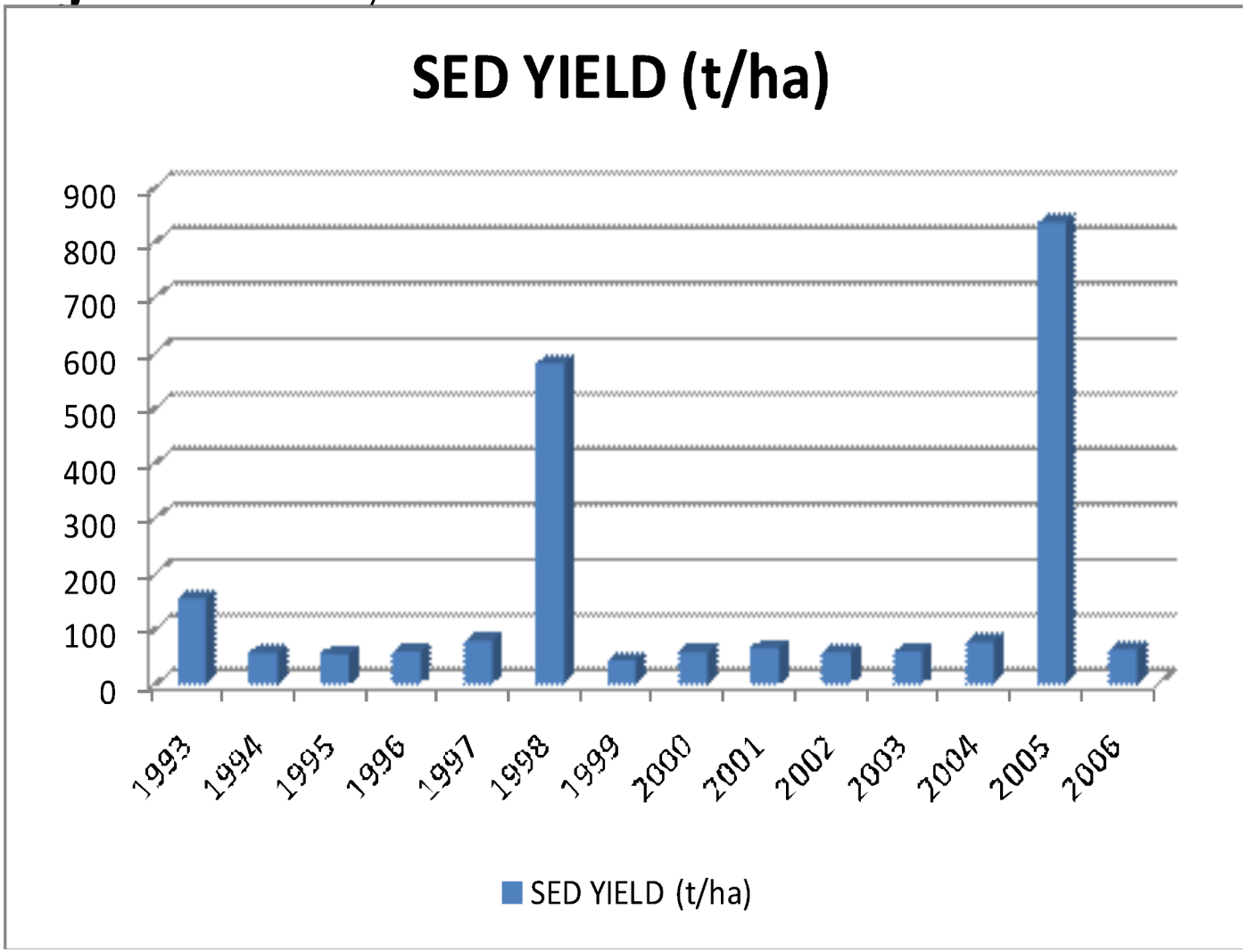
Precipitation and SWAT-simulated runoff (mm/year) for the Jatun Mayu River Watershed



SWAT-simulated runoff (mm) for 1993 for the Jatun Mayu River Watershed



SWAT-simulated annual sediment yield (t/ha) for the Jatun Mayu River Watershed

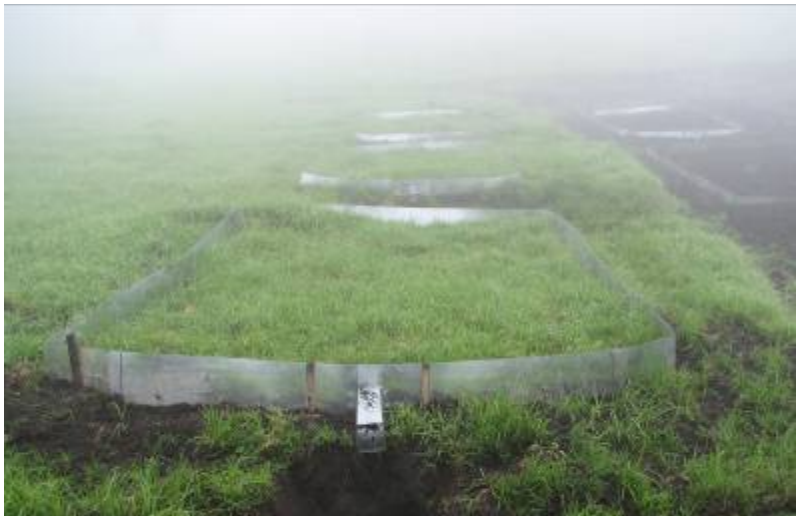


Modeling Activities 2008-09

- Simulate changes in management and landuse based on livelihood study results
- Apply a field-scale model (GLEAMS) to selected individual management systems to provide more detailed input to SWAT
- Evaluate water quantity and quality impacts of different livelihood scenarios

Measurement of Soil Erosion

- Determine quantities of soil lost due to runoff under different management practices
- Quantify nutrient losses due to soil erosion (nutrient balances)
- Longer term: study effects of soil and nutrient loss on biomass productivity
- Activities in Ecuador and Bolivia



Runoff measurement in Tiraque

Runoff monitoring under different cropping systems in the upper zone of the watershed

Evaluation of Improved Varieties

- Evaluate agronomic qualities of maize, potato, barley and bean varieties
- Identify and select, using scientific and participatory methods, based on pest and disease resistance, taste, market and other considerations
- Training in benefits of use of quality seeds

Agricultural Alternatives: Bolivia.
Alleviate pest constraints to annual crops

Study of isolation of endophyte bacteria in faba beans and potato in process

Plant pathogenic nematodes controlled through “bio-fumigation”

Agronomic Research

- Provides information on potential for and impacts of agricultural intensification
- New technologies (validation and diffusion) to increase productive potential
- Improved design of runoff plots: replications now exist for different treatments
- Soils laboratory in Bolivia established

Participatory Activities

- Participation of farmers in field-level research
- Identification of water management goals
- Regular interactions with local decision makers

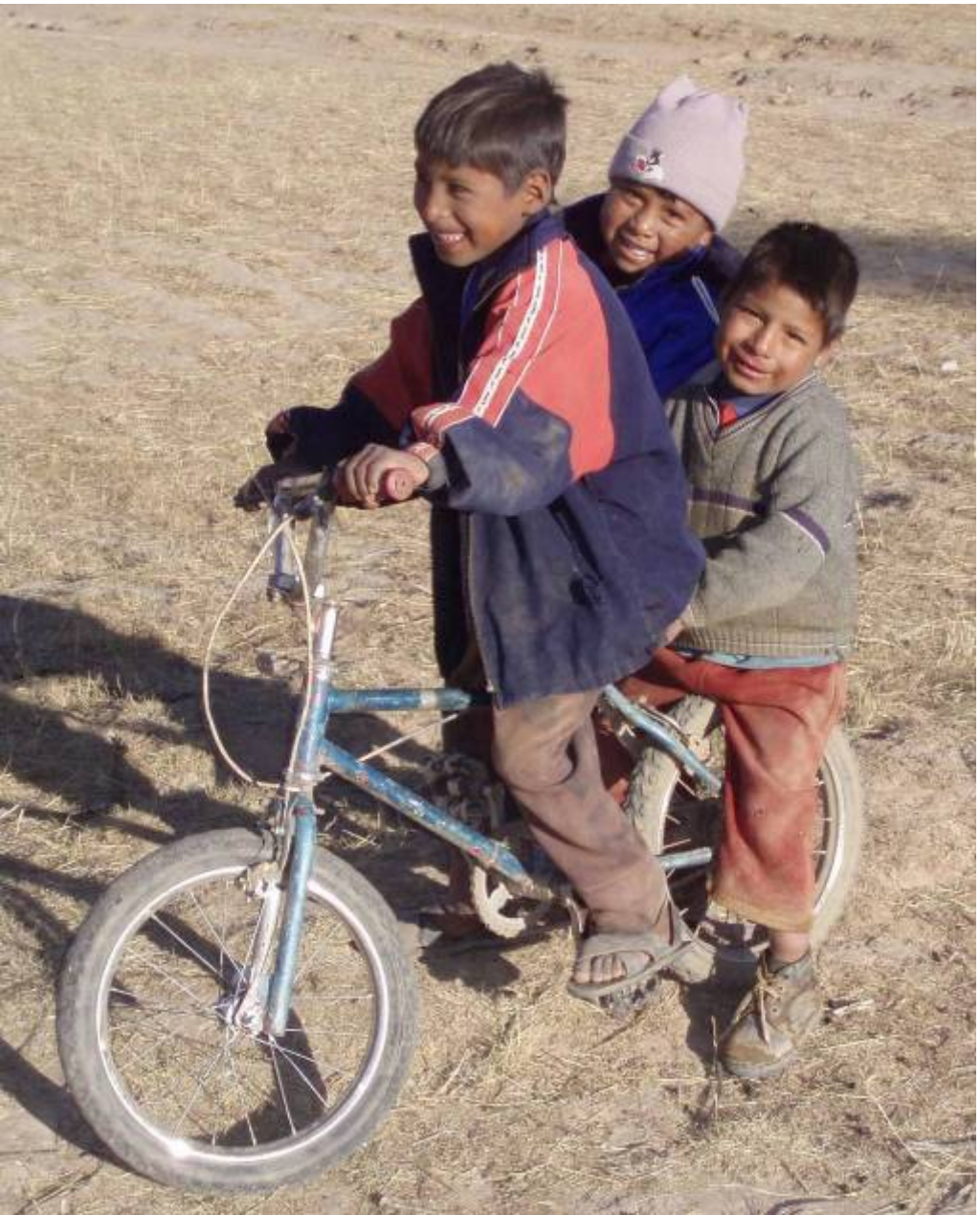
Participatory activities in Bolivia

Training and Research Capacity

- Four graduate students complete degrees (Andrade, Castelhano, Henry, Melnick)
- Many workshops for farmers and local decisionmakers held in both sites

Cross-cutting Activities

- Study of gender, information, and potato marketing in Bolivia being undertaken (Nadezda will discuss on Thursday)
- Extensive collaboration with Conrad Heatwole's initiative: monitoring stations established, local communities engaged, data being collected
- Knowledge-to-action: in each site, activities are being conducted to engage local decision makers; initial K2A interviews have not been completed



THANK YOU