Populations *and societies*

Maps, and more recently aerial photographs and satellite images, have long been used to support decision-making processes. These data are primarily aimed at 'rebuilding' an actual situation through projections, military maps, orthophotos, spatial maps and other maps. These information sources showcase the natural geographical area and, within it, highlight physical resources, human communities and their activities. Interpretation tools are obviously required to give meaning to the shapes, colours and symbols, etc. They can also provide support for the acquisition of many different types of information that could be mobilized in databases or via local know-how and testimony. They may be presented in the form of atlases and information systems.

With computer progress, it is assumed that unlimited power is available for data management. However, experience shows that the full potential of available geoinformation is only utilized when implemented for a targeted approach. This information thus simply serves as an 'intermediate tool' to support individual or collective analysis and debate. It can be used to model phenomena and put forward hypotheses on cause-effect relationships through the identification of key factors, indicators and criteria, whose relevance must then be confirmed. Exchange platforms facilitate data management to gain insight into relationships between activity systems, territorial footprints and impacts on resources. Once this work is done, the image and maps serve as communication tools that enable presentation of results in attractive and accessible forms.

Natural and sanitary risk maps, development plans, cadastral maps and models are all decision support tools. Online mapping can also fuel social discussions.

Geoinformation has thus enhanced the scientific process as well as project decision-making and management processes. This is the approach discussed and illustrated in the present chapter through many users and various applications.

Historians and geographers can analyse and understand changes in land-use patterns through studies on road networks or landscape dynamics. Political scientists use different sources of available geographical data to interpret territorial modifications highlighted by war and peace dynamics. Geographic information systems facilitate the analysis of heterogeneous multisource and multidate data for such studies. Remote sensing images can also be used to enhance land management in Madagascar, for instance, where very high spatial resolution images are used as base maps–communities may trace the boundaries of plots on these maps and draw up cadastral maps at reasonable cost. Correlation of geographical data and health data enables epidemiologists to detect certain environmental or social factors responsible for disease distributions. Finally, land planners propose future scenarios in collaboration with different territorial stakeholders, and this process is facilitated by the use of information systems as communication tools.

Annelise Tran (UPR AGIRs)
& Jean-Philippe Tonneau (UMR TETIS)

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▲ *Group of children eating from the same plate at Puerto Salinas (Bolivia).*

Main teams

EA GESTER - Gestion des Sociétés, des Territoires et des Risques
(see page 49)

FRE MTE - Mutations des Territoires en Europe
(CNRS, UM3, UPVD)
33 scientists, with 2 involved in the topic
Director: Geneviève Cortes,
genevieve.cortes@univ-montp3.fr
http://recherche.univ-montp3.fr/mte

UMR TETIS - Geoinformation and Earth Observation for Environment and Land Management
(see page 8)

UPR AGIRs - Animal and Integrated Risk Management
(CIRAD)
40 scientists, with 6 involved in the topic
Director: François Monicat,
francois.monicat@cirad.fr
www.cirad.fr/en/research-operations/research-units/animal-and-integrated-risk-management

UR Dynamiques socio-environnementales et gouvernance des ressources
(IRD)
Team *Gestion sociale de la nature*
30 scientists, with 5 involved in the topic
Director: Geneviève Michon,
michon@mpl.ird.fr
www.mpl.ird.fr/ur199

UR EPIPREV - Épidémiologie et prévention : environnement et efficacité des interventions*
(IRD)
14 scientists, with 2 involved in the topic
Director: Kirsten Simondon,
kirsten.simondon@ird.fr
www.mpl.ird.fr/epiprev
***This unit was disbanded in January 2009.**

...continued on page 59

Differential exposure of riverside populations of Río Beni (Bolivian Amazon) to mercury contamination

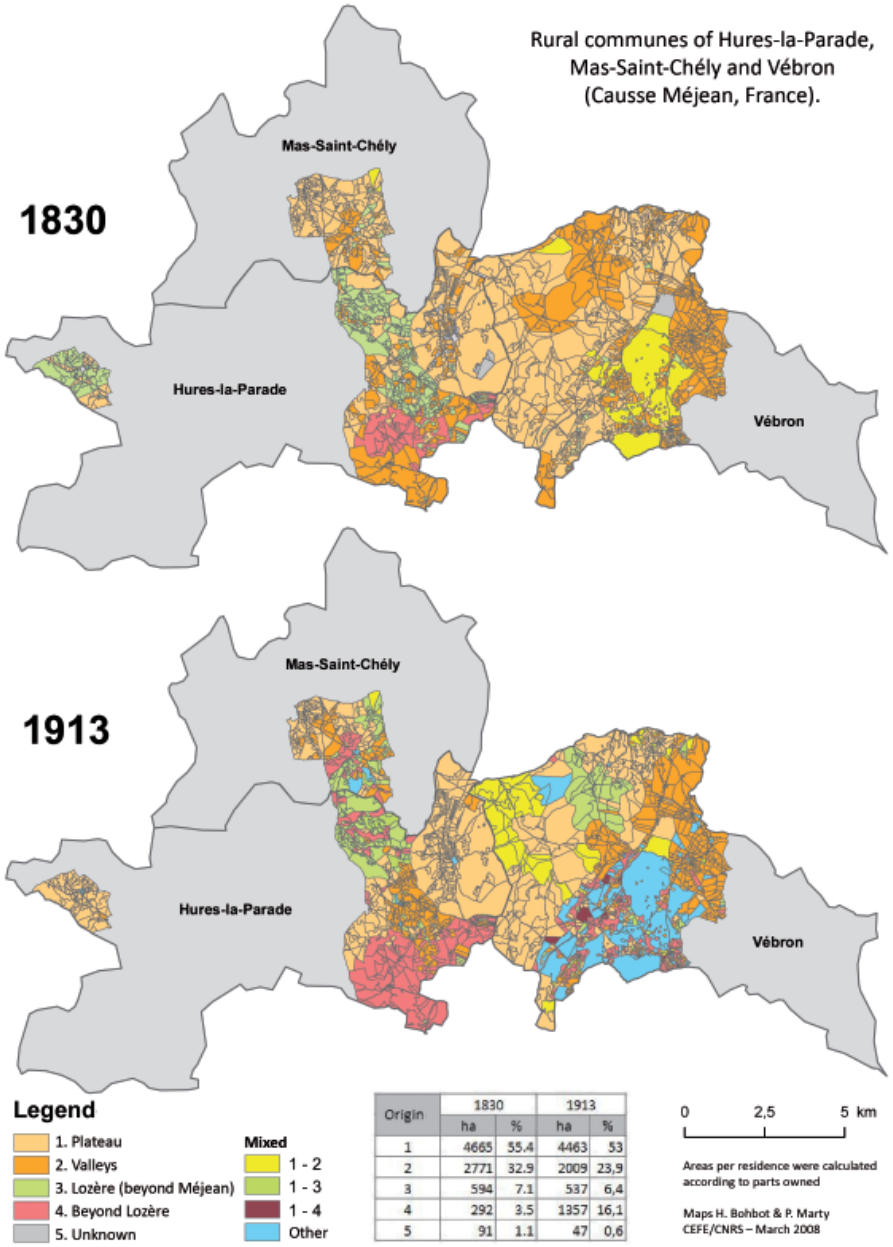
In Bolivia, epidemiological research concerning the variability in methyl mercury contamination in riverside communities of Río Beni has raised a geographical problem, where the contamination level is an indicator of lifestyles and spatial practices. What nonbiological factors associated with territorial practices and resource management are responsible for inequalities with respect to this contamination?

Two surveys were jointly conducted in 15 riverside communities, i.e. an epidemiological survey of women and their children and a geographical survey to highlight contrasting areas in terms of contamination. The population studied was found to use many different resources, ranging from farming, hunting, gathering, logging and other income-generating activities (house and boat building, etc.). However, the relative importance of these different activities has created an imbalanced situation with respect to health risks. A classification of resource management and exploitation strategies was drawn up on the basis of the findings of a multidisciplinary cross-sectional survey. This revealed five specific groups, with heterogeneous levels of mercury contamination.

This study, which was carried out by the EPIPREV (IRD) team, revealed the influence of social practices on the health risk in riparian populations of Río Beni in distinctly separate areas. Fishing was found to have a role in the degree of exposure, but this was significantly influenced by the specialized or diversified resource exploitation systems in which the families were involved. Consequently it was found that the population's main activity determined the contamination level more than the proximity to Río Beni.

Studies are currently under way to assess the structure of territories, inhabitants' practices and resource availability. The aim is to reduce exposure risks through better environmental management.

Contacts: Céline Tschirhart, celinetchi@hotmail.com
& Pascal Handschumacher, handschup@hotmail.com



Origin	1830		1913	
	ha	%	ha	%
1	4665	55.4	4463	53
2	2771	32.9	2009	23,9
3	594	7.1	537	6,4
4	292	3.5	1357	16,1
5	91	1.1	47	0,6

▲ *Evolution in landowners' residences between 1830 and 1913.*

Landscape dynamics and transformations: ecological and socioeconomic processes

A database was built with ArcGIS® software on the basis of historical spatial information describing land-use patterns in the Grands Causses region (France) with the aim of analysing the role of human societies in landscape dynamics.

Cadastral maps and index maps mentioning land cover types were digitized in order to determine the landscape structures that prevailed in the 19th century. This information was matched with older written sources in order to get a clearer picture of the peri-Mediterranean limestone mountainous landscape during the 1700-1900 period, i.e. treeless areas with substantial cereal cropping. Information for the early 20th century highlighted the impact on the landscape of the transition to an economy based on sheep production, i.e. a decrease in cropping and an increase in semi-natural grasslands, with a slight increase in forests.
In addition to the land-use patterns, cadastral maps enabled an analysis of a number of social parameters, including land appropriation (private or public), evolution in property sizes, and location of owners' residences.

Information describing recent land-use stages (late 20th century) was derived from photointerpretation studies or remote sensing. They revealed major changes in the landscape structure, with a very marked increase in forest area. This was partly due to reforestation, but especially to spontaneous forest growth from old core forests. These changes should be correlated with the modernization of livestock production systems which utilize semi-natural grasslands resources to a much lower extent. The dynamics of the landscape transformation, which began when cereal cropping was abandoned in the late 19th century, were further strengthened by the reduction in grazing pressure. These transformations are now socially considered as being problematic from biological (biodiversity loss) and cultural standpoints.

Contacts: Pascal Marty, pascal.marty@cefe.cnrs.fr
Hervé Bohbot, herve.bohbot@cefe.cnrs.fr
Elie Pélaquier, elie.pelaquier@univ-montp3.fr
& Jacques Lepart, jacques.lepart@cefe.cnrs.fr

Documenting the impossible: the development of a GIS for a territory of high strategic importance- the Greek-Albanian border region

The Greek-Albanian border region is a stretch of land and sea located relatively close to the Italian coast. The forests and beaches of Corfu are visible from the tops of the rugged mountains. For almost 50 years, however, this Balkan sector was one of the most tightly sealed and guarded parts of the former Iron Curtain. The state of war declared in 1940 between Greece and Albania was only lifted in 1987. The high militarization in this zone and strict border control 'froze' activities in many villages and forced marginalized populations into exile. Since the early 1990s, despite the many conflicts affecting southern Albania, the situation has cooled off and relationships between Athens and Tirana have gradually returned to normal.

How did the transition from the opened Ottoman *vilayet* of Ioannina (which disappeared in 1912)–a hub of activity and trade–to such fragmented areas take place? How can the recent transformation of such seemingly opposed territories and landscapes be explained?

Different GIS and remote sensing tools were implemented to determine the successive territorial changes that have taken place. The initial project (CNRS, *École Française d'Athènes*) was hampered by many factors, including the fact that access to all mapping information and images was prohibited until just recently. However, highly varied data was still collected during several field trips: Ottoman, Greek and Albanian statistics (population, agriculture land use) established over the last century, old aerial photographs, declassified documents from

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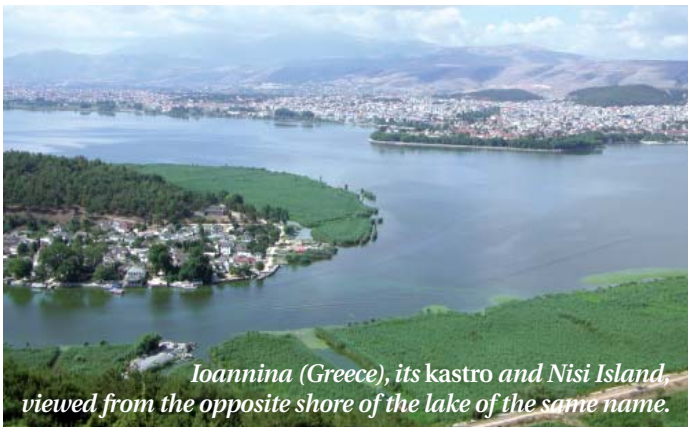

Ioannina (Greece), its kastro *and Nisi Island, viewed from the opposite shore of the lake of the same name.*

CORONA satellite* data, Landsat MSS archives, SPOT 5 and QuickBird images of the towns of Gjirokastër and Ioannina. This effective use and analysis of multisource spatial data by a stakeholder during his research (for potential publication of the findings) is an essential step in this physical and social geographical approach–for this work, the geographer had to be able to adapt to different spatial information processing methods.

Contact: Régis Darques, regis.darques@univ-montp3.fr

* American military photographic reconnaissance satellites (1960–1980).

Remote sensing–a key land reform tool in Madagascar

The Malagasy land reform, which has been under way since 2005 with the support of different expert teams (including UMR TETIS and UMR INNOVATION*), is based on land management decentralization. Municipalities with a 'land office' can now manage untitled private land for which they can award land certificates (CF) after local land recognition commissions (CRL) have been held.

Very high resolution orthorectified and georeferenced remote sensing images provide mapping templates for drawing up, on a municipal level, local land-use maps (PLOF) that are listed in different land acts: titled private property, untitled private property, special status areas, etc. During CRLs, certificate requestors and their neighbours sketch out the boundaries of plots to be certified based on 'land markers' that are visible on the images (irrigation canals, bunds, trails, remarkable trees, buildings, etc.). The image thus serves as a base for local participatory and contradictory land mapping. Hardcopy versions of each CF includes a PLOF extract drawn on the image, enabling owners to view the boundaries of their plots and their neighbours' plots. Remote sensing satellite (QuickBird and Ikonos) images and aerial images are used by local authorities and Malagasy land services.

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The image resolution range is 0.5-1 m. They are projected in the Laborde Madagascar system and used at 1:2500 to 1:10000 scale.

Costs and times for acquiring such images for large surface areas are inevitable issues when archival images are considered insufficient.

In late 2008, 300 municipalities out of 1550 had a land office and a PLOF, which means that considerable investment would be necessary for acquisition of the corresponding images and training on their use for land management purposes.

Contacts: Pascal Thinon, thinon@supagro.inra.fr & André Teyssier, ateyssier@cirad.mg

* UMR INNOVATION: Innovation and Development in Agriculture and the Agrifoods Sector (Montpellier SupAgro, INRA, CIRAD)

▲ *Delivery of an act of recognition for a property in the commune of Miadanandriana, Madagascar (November 2006).*

Information systems to enhance territorial intelligence: a case study in the Thau area (France)

B. Térébenec © CPIE Bassin de Thau

▲ *Relief model for* Agenda 21 *at Villeveyrac (France).*
Source: Association Pour le Bassin de Thau.

Many problems are often encountered when striving to ensure the consistency of territorial public policies in France, especially the capacity of stakeholders to get organized to collectively address the issues within their territory. This challenge is substantial since all concerned parties and the local population must, by law, be involved in the development and implementation of territorial projects. In this new setting, collective learning capacities within networks of mixed stakeholders are dependent on the availability of information and communication tools.

The joint research unit (UMR) TETIS has been collaborating with other laboratories, and in close partnership with the *Syndicat Mixte du Bassin de Thau* and different stakeholders in Thau Basin, to develop and implement tools that will favour integrated sustainable development (territorial consistency and orientation scheme, water planning and management scheme, Agendas 21).

Information and communication tools implemented or being developed are highly varied and address different levels of stakeholder participation. A few examples are: the MDWeb tool for inventorying and making effective use of information resources available within the stakeholder network, 'stakeholder-guided' cartography that combines observatory data and local know-how, physical relief models to facilitate territorial dialogue, a cellular automaton combined with a geographic information system to represent the dynamics of urban sprawl from 1940 to 2020, new tools based on Web 2.0 and online mapping to support large-scale public debates *(INTERnet pour la MEDiation* project [INTERMED]). In addition to contributions towards the development and dissemination of these innovations, UMR TETIS is conducting an assessment of their uses to measure progress towards a form of territorial intelligence.

Contact: Pierre Maurel, pierre.maurel@teledetection.fr

For further information on MDWeb: www.mdweb-project.org

Andean road networks: technical history and population geography

The spatial distribution of transportation and communication networks reflects the social, economic and political structure and technological resources of a society, while also being a key factor in its development. Historical and geographical approaches to these spatial networks are studied by the research unit (UR) *Dynamiques socioenvironnementales et gouvernance des ressources* (IRD).

During pre-Columbian times, the main route for the movement of people, linking local confederations, was via the Andes. The 'Inca Road' followed previous trails. There was technical progress in the quality of stopping-station construction, maintenance and organization because the empire needed roads to control their territories and populations. The Inca Road, spanning over 4 000 km, ran straight over mountains, high plains *(Altiplanos)* and through valleys without difficulty. The slopes were not very important for pedestrian travel until the advent of the industrial revolution.

In Peru and Ecuador, most people now live on the coastal plain. The Panamerican route shifted accordingly. The initial project was based on a railway network, but discussions are now focused only on the development of a road system. 'Road' and 'Panamerican' are sometimes synonymous in popular language. Lorry transport overtook railway transport around the middle of the 20th century since trains are unable to climb slopes of more than 4%. Lorries nevertheless lose 10% of their power with every 1 000 m elevation step. The choice of development between the *Altiplano* at 4 000 m and the coastal plane is not as simple as it seems.

A new route is taking shape on the eastern side of the Andes. From Venezuela to central Peru, it is only disrupted and dangerous in the Amazonian foothills region due to violent situations. The population along the road is quickly increasing. Coca and opium poppies are not present everywhere. To travel from Caracas to La Paz, it would be faster to go via the inside of the Andean Arch than by the outside, as is currently the case. The direct route via Manaus and the Transamazonian highway already links the two most remote Andean capitals–this is and will be the fastest itinerary.

Contact: Pierre Gondard, pierre.gondard@ird.fr

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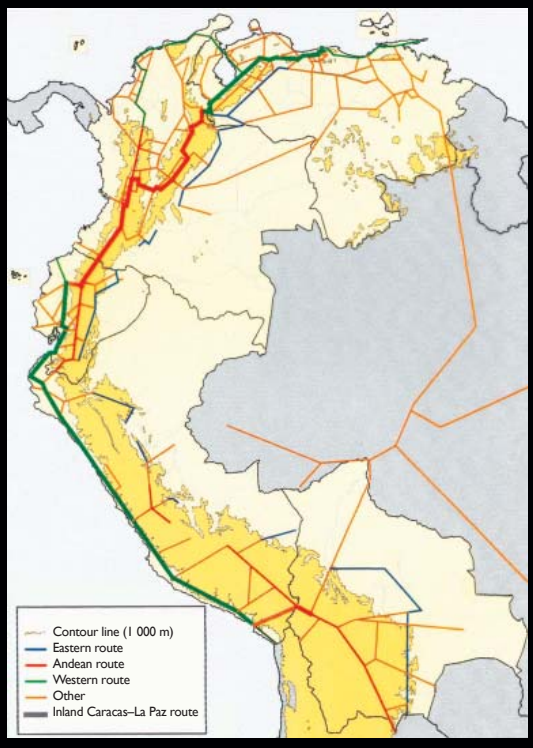
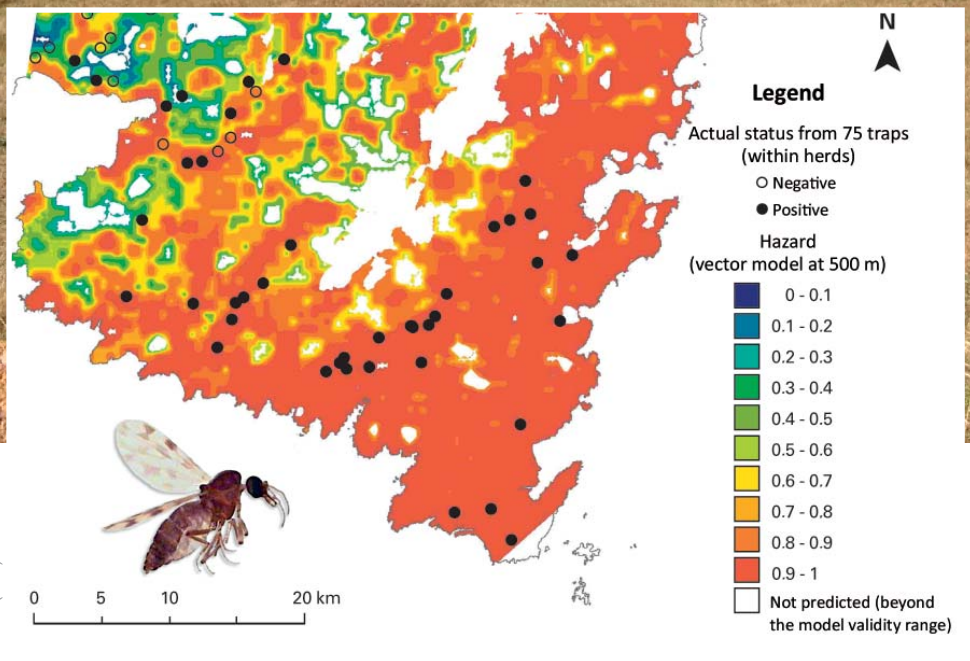


▲ *Inland Caracas–La Paz route.*
Source: South America (northwestern) 1/4000000 and ORELLANA information group.



▲ *Hazard map for the presence of the midge* Culicoides imicola *(indicator between 0 absence and 1 presence): entomological approach.*

▲ *Background image: Environmental approach – Corsican landscape.*

▶ *Epidemiological approach: a herd of Corsican sheep.*

Geomatics and epidemiology: satellite images to track midges

The distribution of vectors (insects and mites that transmit pathogens) and communicated diseases is shifting as a result of climate change and human activities. The AGIRs team and the research unit (UMR) TETIS are collaborating to study the key environmental factors determining the disease distribution.

The topics investigated concern the search for epidemiologically useful indicators that could be obtained from satellite images and the application of geomatic tools for the spatialization of health hazards. One thesis research project derived from this partnership, carried out in collaboration with the *Université de Franche-Comté*, is aimed at identifying suitable landscapes for *Culicoides imicola*, a small exotic midge that transmits bluetongue disease to sheep, on SPOT satellite images of Corsica combined with field information. The recent arrival (late 1990s) of this midge in the Mediterranean Basin led to a major epizootic (animal epidemic) of bluetongue disease. Following a large-scale midge trapping campaign in sheep herds in southern Corsica, environmental characteristics such as land-use and spatial vegetation patterns, and the altimetric and hydrographic features around sites where the midge was present, were compared with characteristics in the vicinity of sites where the midge was absent. The results indicated that the presence of this midge was associated with environments where the vegetation cover had low chlorophyll activity and where the land-use pattern was highly diversified. Hazard maps were drawn up on the basis of these results in order to target surveys of the disease and vectors in both infected and uninfected zones.

Contact: Hélène Guis, helene.guis@cirad.fr

Main teams

URP Pastoralism
(see page 38)

US ESPACE - Expertise et SPatialisation des Connaissances en Environnement
(see page 8)

Other teams focused on this topic

UMR CBGP - Center for Biology and Management of Populations
(see page 43)

UMR CEFE - Centre of Evolutionary and Functional Ecology
(see page 43)

UMR G-EAU - Water Resource Management, Actors and Uses
(see page 44)