P.-A. Pissard © UMR TETIS

Modelling *biodiversity scenarios*

Modelling and statistical analysis (biomathematics) underpin much of the biodiversity research conducted in Montpellier and region (France). This research is further supported by reference databases that span a highly diverse range of terrestrial and aquatic, temperate and tropical ecosystems. These databases also cover interactions between 'biodiversity dynamics' and 'activities of humans and societies'.

Several Montpellier-based research teams have an internationally recognised innovation potential with respect to major models that have a pivotal role in the following fields: evolutionary genomics, population genetics, evolutionary ecology, population dynamics, plant architecture and forest structures, ecosystem functioning, spatial ecology, and 'biodiversity–human activity' interactions. These methodological developments are combined with many transfer initiatives (provision of software and modelling platforms, training workshops) and implementations, especially with respect to Mediterranean and tropical observatories. The involvement of biomathematics specialists thus ensures the integration of methodological research in biodiversity topics. In turn, this integration enhances the relevance of such methodological activities while constantly paving the way to further advances in an especially rich and complete interdisciplinary setting.

The inclusion of spatial dynamics is a key development focus in biodiversity science modelling. These spatial modelling developments concern research on the impact of fragmentation and dispersion of individuals on the dynamics of metapopulations and metacommunities, and on interactions between spatial structures and functional flows in landscapes and ecosystems. The prediction of species distribution ranges on the basis of the environment and their life history traits, of spatial evolutionary scenarios following integration of socioenvironmental data and research on landscape indicators of environmental states and dynamics are also essential for gaining insight into possible impacts of global change and the risk of extinction of some species, but also for helping to improve global management of areas.

Monitoring and prediction of spatial distribution dynamics illustrates the intrinsic connection between modelling and databases whose exploitation has been facilitated by the development of bioinformatics, in the broadest sense of the term. The range of different databases is enhanced by the diverse range of research studies. For instance, botanical collections (herbaria), studies and databases on physiological, functional and demographic traits of species, knowledge sharing and dissemination via the web, thus promote major development on relationships between geographical distributions and biological traits of species, as well as between biodiversity and uses through the impact of humans on the environment and its functioning (pressures and forcings), and thereby on ecological niches. The connection between collections and phylogeny and phylogeography research is being concomitantly developed. Genome 'barcoding' programmes are being developed on crop pests and disease vectors. Moreover, long-term programmes on mosquito resistance to pesticides, and on vertebrate (birds, reptiles) population dynamics have generated substantial databases, which are the source of many publications on population biology mechanisms. The species community monitoring data cover tropical (forest and lagoon) and Mediterranean (Mediterranean Environment Research Observatory) ecosystems and, since these data span long periods, they represent a very valuable tool in the current global change setting.

Major and already visible advances in the field include increasingly close integration of databases and modelling, a greater role of simulations, the development of different management support scenarios, and affiliations with environmental observatories.

Jean-Dominique Lebreton (UMR CEFE),
Daniel Barthélémy (UMR AMAP),
Pierre Couteron (UMR AMAP)
& Frédéric Huynh (UMR-S ESPACE-DEV)

◀ *RapidEye satellite view of the community of Nîmes, France (resolution: 5 m pixel size), showing a yellow box on the bottom right corresponding to an IGN aerial orthophotographic image frame (50 cm pixel size).*

The red frame near the centre of the IGN aerial image corresponds to a high resolution ULM image frame (2 cm pixel size).

The three images were selected and framed to provide a zoom display: from satellite to IGN orthophoto to ULM image.

Modelling *biodiversity scenarios*

Main teams

UMR AMAP
Botany and Computational Plant Architecture
(CIRAD, CNRS, INRA, IRD, UM2)
44 scientists
Director: Pierre Couteron, diramap@cirad.fr
http://amap.cirad.fr
▶ Presentation page 58

UMR ESPACE-DEV
Espace pour le développement
(IRD, UM2, Université Antilles-Guyane, Université de la Réunion)
60 scientists
Director: Frédéric Huynh, huynh@ird.fr
www.espace.ird.fr
▶ Presentation page 62

UR Green
Management of Renewable Resources and Environment
(CIRAD)
15 scientists
Director: Martine Antona, martine.antona@cirad.fr
www.cirad.fr/ur/Green
▶ Presentation page 60

Other teams focused on this topic

UMR CBAE
Centre de Bio-Archéologie et d'Écologie
(CNRS, EPHE, INRAP, UM2)
Around 20 scientists
Director: Jean-Frédéric Terral, terral@univ-montp2.fr
www.umr5059.univ-montp2.fr
▶ Presentation page 28

UMR CBGP
Center for Biology and Management of Populations
(CIRAD, INRA, IRD, Montpellier SupAgro)
35 scientists
Director: Flavie Vanlerberghe, Flavie.Vanlerberghe@supagro.inra.fr
www.montpellier.inra.fr/CBGP
▶ Presentation page 10

Tour du Valat
25 scientists
Director: Jean Jalbert, jalbert@tourduvalat.org
www.tourduvalat.org
▶ Presentation page 53

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Bioinformatics *and biomathematics* of plant biodiversity

The multidisciplinary staff of the joint research unit (UMR) ***Botany and Computational Plant Architecture*** **(AMAP, CIRAD, CNRS, INRA, IRD, UM2)** includes botanists, ecologists, agronomists, forestry specialists, applied mathematicians and computer science specialists. Most of the team is based in Montpellier (France), with others permanently stationed in New Caledonia, French Guiana, Vietnam and India. Research carried out by AMAP starts from structural botany, paleobotany and systematics studies to result in modelling and simulation of plant architecture, and plant cover and landscape structure and diversity.

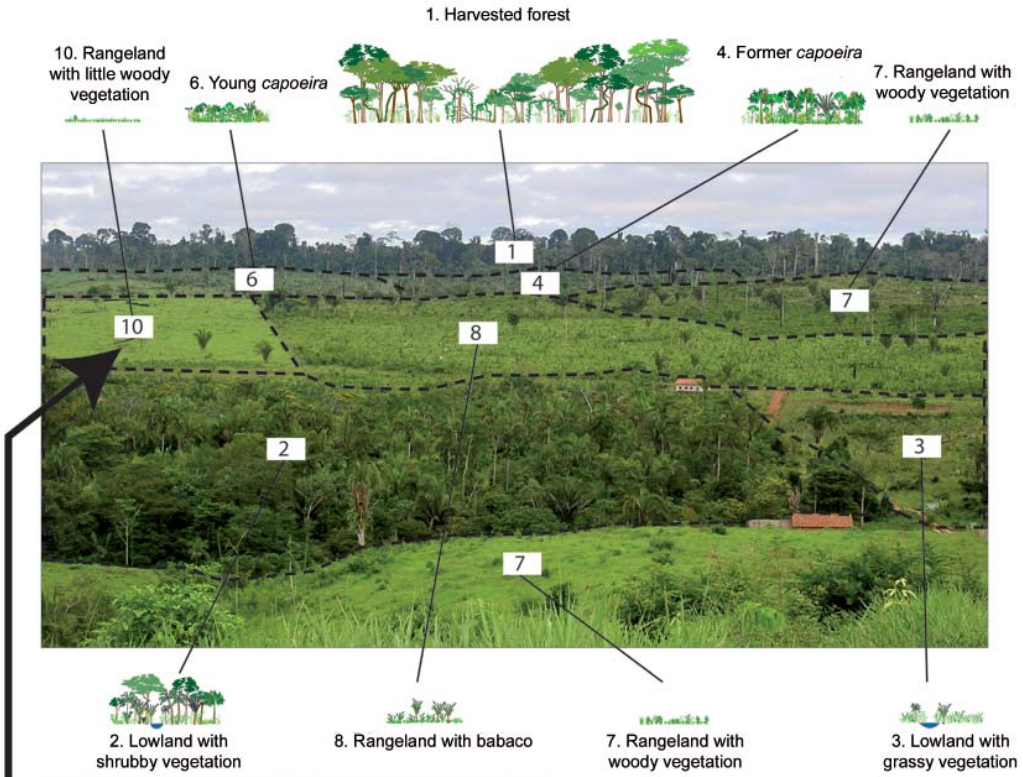
The main aim of AMAP is to contribute to the emergence of bioinformatics and biomathematics of plant biodiversity—plants, plant stands and landscapes—as a complement to research carried out by other units in the fields of functional and evolutionary ecology, developmental biology, ecophysiology and genome bioinformatics. Methodological investment is one aspect of this complementarity, in partnership with statistics, informatics and physics laboratories.

By focusing on the organization of plant covers, plant architecture and the morphology of plant organs, the unit is striving to develop powerful mathematical and informatics formalisms able too describe, analyse and represent the topology and geometry of studied biological objects (from organs to landscapes), while also pooling, in generic models, ever increasing knowledge on the development and diversity of plants and their environmental regulations. The dissemination of pooled knowledge and developed methods is an essential part of AMAP's activities, via training and teaching (traditional or distance learning), as well as by developing and providing access to software, compiling and exploiting databases.

The research unit is an active user and manager of herbaria (Cayenne and Nouméa) and collections (paleobotanic collection at UM2), while managing scientific aspects of the UM2 herbarium. Moreover, AMAP has a histology and biomechanics laboratory in its Montpellier facilities.

Internationally, some of the main biodiversity research partners are: *Centro Regional Universitario Bariloche* (Argentina), Department of Ecology and Evolutionary Biology, Kansas University, *Museu Paraense Emilio Goeldi* (Belem, Brazil), *Institut de Recherches Agronomiques de Guinée,* French Institute of Pondicherry (India), Invasive Species Specialists Group (New Zealand), Center for Ecostratigraphy and Palaeobiology, Macquarie University (Australia), etc.

The partners in France include: the *Équipe-Projet IMEDIA* of the *Institut national de recherche en informatique et en automatique,* Tela Botanica, different joint research units *(ECOlogie des FOrêts de Guyane, Biodiversité Gènes & Communautés, Centre de Biologie et de Gestion des Populations, Diversité et Adaptation des Plantes Cultivées,* etc.). •••



A.-L. Laques © IRD

◀ *Identification of constituents and counting of landscape elements (babaco plants) via field observations and satellite images.*

Monitoring the spatial dynamics of biodiversity and the impact of public policies—integrated analysis, from observation to identification

On a plant scale, very high resolution images are used to differentiate a species and count certain individuals (e.g. babassu palm, *Attalea speciosa*, by its shadow). Useful species isolated in crop fields and rangelands are investigated to gain insight into variations in their spatial distribution and to quantify them in order to characterize (typology) agrosystems and match them, through an integrated environment–society approach, with their production, or generally their functioning.

On a landscape scale, plant biodiversity dynamics can be spatiotemporally mapped from satellite images via estimates of the environmental complexity in interdisciplinary studies. Landscape changes and concomitant biodiversity variations are also correlated with public policies in order be able to estimate their impact on recorded changes. A deliberately simple methodological approach was developed that could be broadly applicable to different tropical forest areas.

The results are designed to be included in scenario models used in socioenvironmental observatories such as the French Observatoire Régional de l'Environnement. They are also disseminated online through an information system (MDweb) developed (partnership involving IRD, UMR ESPACE-DEV, UM2, LIRMM and a commercial partner—Geomatys), approved and in accordance with European directives. This generic cataloging and data location tool provides managers and local communities with ready access to acquired knowledge.

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Michel Petit, Michel.Petit@ird.fr
& Jean-Christophe Desconnets, Jean-Christophe.Desconnets@ird.fr

Other teams focused on this topic

UMR CEFE
Centre of Evolutionary and Functional Ecology
(CIRAD, CNRS, EPHE, INRA, IRD, Montpellier SupAgro, UM1, UM2, UM3)
125 permanent staff (or 160 scientists)
Director: Philippe Jarne,
philippe.jarne@cefe.cnrs.fr
www.cefe.cnrs.fr
▶ Presentation page 24

UMR CMAEE
Emerging and Exotic Animal Disease Control
(CIRAD, INRA)
36 scientists
Director: Dominique Martinez,
dominique.martinez@cirad.fr
▶ Presentation page 17

UMR Eco&Sols
Functional Ecology and Biogeochemistry of Soils and Agroecosystems
(CIRAD, INRA, IRD, Montpellier SupAgro)
63 scientists
Director: Jean-Luc Chotte,
jean-luc.chotte@ird.fr
www.montpellier.inra.fr/ecosols
▶ Presentation page 29

UMR ECOSYM
Écologie des systèmes marins côtiers
(CNRS, IRD, UM2)
82 permanent staff
Director: Marc Troussellier,
marc.troussellier@univ-montp2.fr
www.ecolag.univ-montp2.fr
▶ Presentation page 37

UMR EME
Exploited Marine Ecosystems
(IFREMER, IRD, UM2)
56 scientists
Director: Philippe Cury,
philippe.cury@ird.fr
www.crh-sete.org
▶ Presentation page 38

UMR ISEM
Institut des Sciences de l'Évolution de Montpellier
(CNRS, IRD, UM2)
117 scientists
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www.isem.cnrs.fr
▶ Presentation page 8

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Support modelling—*interactions between* natural resource uses and *ecosystem sustainability*

The conditions of interaction and arbitration between ecosystem conservation and development are pivotal to sustainable environment management. Research is called upon to deal with these issues, so as: to gain insight into and boost awareness on the complex social and ecological processes involved and thus ensure their viability; to support management processes that include environmental aspects over the long term, i.e. to give real substance to the 'integrated management' and 'adaptive management' concepts, and; to assess the imbalanced situation with respect to information and the participation of concerned stakeholders. The overall aim of the research unit (UR) ***Management of Renewable Resources and Environment*** **(GREEN, CIRAD)** is thus to provide knowledge, methods and tools that will enhance the understanding of interactions between natural resource uses and ecosystem sustainability, and also to provide support for collective management processes.

The research unit addresses this dual objective through multidisciplinary research—agronomy, modelling, informatics, ecology, geography, economy, sociology and anthropology are the fields represented by the unit's 15 agents, half of whom are posted in universities and in partnership research platforms.

The UR GREEN research project is structured along a cross-sectoral line entitled 'Adaptation and transformation of socioecological systems', and two targeted research lines entitled 'Organization–environment interactions' and 'Co-construction of models, simulations and learning'. Some factors and mechanisms that contributed to the adaptation and transformation of socioecological systems are specifically targeted: changes in viewpoints and/or knowledge and/or practices, power plays, networking, and changes in the socioeconomic or environmental setting. The relative importance of these mechanisms is estimated through research on the topic of land in Sahelian Africa and Réunion, of biodiversity in Brazil and Madagascar, of agrobiodiversity in West Africa and Latin America, and of catchment management in Asia.

One of the team's unique methodological features is in jointly implementing computer simulation tools (multiagent) and role-playing games within a communications platform to facilitate the elicitation and exchange of viewpoints between different stakeholders. UR GREEN and researchers from Cemagref, CNRS and INRA have gradually formed a scientific network, which currently includes around 50 individuals, based on this so-called 'companion modelling' approach*. •••

* For further information: **www.commod.org**

R-SYST: systematic network and tool for assessing organisms of interest

A. Franc © INRA

The R-SYST network links some 12 French research teams, including two joint research units located in Montpellier—CBGP and AMAP. It aims to characterize many organisms of interest at molecular and phenotypic levels, including trees, insects, fungi, microalgae and bacteria. The overall goal is to draw up a dictionary of specimens characterized by a set of different features: taxonomic (species names validated by specialists, synonyms and associated links, *Id Fauna* and *Flora Europea*), geographic and phenologic (distributions, monitoring dates harvest locations, GIS coupling), phenotypic (morphological traits, life history traits, etc.) and genotypic (sequences of different coding or noncoding markers).

This dictionary—at the crossroads of several disciplines and involving complementary tools (taxonomy, barcoding and phylogenetics)—will be available for scientists and professional nonspecialists in several areas: biodiversity management, pest monitoring, wood traceability, water quality and, ultimately, the identification of organisms of medical or veterinarian interest. R-SYST, which is highly supported by INRA, is directly or indirectly linked to several international projects, including QBOL (the European Quarantine Barcode of Life project), TreeBOL (a worldwide tree barcoding project), iBOL (International Barcode of Life, Genome Canada), CBOL (Consortium for the Barcode of Life). These projects concern the entire international barcode of life research community and they provide a link with organizations involved in biodiversity.

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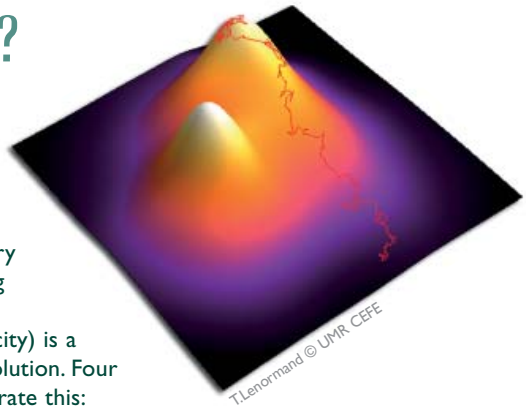
For further information:
- R-SYST: **w3.pierroton.inra.fr/r-syst**
- iBOL: **www.dnabarcoding.org**
- CBOL: **www.barcoding.si.edu**
- QBOL: **www.qbol.org/UK**

◀ **Zygaena purpuralis** *(Brünnich, 1763) and* **Parnassius appolo** *(Linnaeus, 1758), a protected species in Europe, on* **Centaurea** *sp., in Valais region (Switzerland).*

Evolutionary biology—a predictive science?

The prediction of evolution, as for all complex phenomena, is a complicated issue. The topic should thus be approached with considerable reserve, especially since evolution is generally a slow process. Despite the fact that the relevance of making such very long-term predictions may be readily doubted, it is interesting to look at this issue for several reasons.

The first reason is methodological. Theories can be tested and quantitatively refined on the basis of predictions. This is a vital strategy in experimental science, and in evolutionary biology it is the only way to avoid strictly historical discussions. Two key elements have changed the stakes in recent years. First, it is now clear that evolution is a very rapid process, especially during periods of major environmental change. This 'contemporary evolution' topic is particularly relevant in the current global change and public health (pathogen evolution) setting. The second element is the increase in long-term laboratory experiments on microorganisms. Because of their short generation time, it is possible to monitor the evolution on tens of thousands of generations, and even better to get back to the past at any time simply by taking stored samples out of the freezer when needed for these experiments.



T.Lenormand © UMR CEFE

The second reason is more fundamental. It is necessary to distinguish between random events and necessity in evolutionary processes when making predictions. Clearly, randomness (stochasticity) is a key driving force in evolution. Four general situations illustrate this: (1) stochasticity markedly contributes to the maladaptation that is often noticed in all organisms, (2) it governs evolution when selective differences are scant (or neutral—this relative indeterminism can then lead to a plethora of forms and functions), (3) it can sometimes lead to quick evolutionary transitions in the form of 'genetic revolutions' (but this is still highly controversial), and (4) it could determine natural selection in many 'adaptation to uncertainty' situations.

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▲ **The adaptation process is often presented as a trajectory in an 'adaptive landscape'.**
It is especially important to understand this representation when evolution can be predicted along with the different associated issues.

Other teams focused on this topic

UMR LAMETA
Laboratoire Montpelliérain d'Économie Théorique et Appliquée
(CNRS, INRA, Montpellier SupAgro, UM1)
Around 40 scientists
Director: Jean-Michel Salles,
sallesjm@supagro.inra.fr
www.lameta.univ-montp1.fr
▶ Presentation page 46

UMR LECOB
Benthic Ecogeochemistry Laboratory
(CNRS, UPMC)
16 scientists
Director: Nadine Le Bris,
lebris@obs-banyuls.fr
http://lecob.obs-banyuls.fr
▶ Presentation page 41

UMR LOMIC
Microbial Oceanography Laboratory
(CNRS, UPMC)
18 scientists
Director: Stéphane Blain,
stephane.blain@obs-banyuls.fr
http://lomic.obs-banyuls.fr
▶ Presentation page 40

UMR LSTM
Laboratory of Tropical and Mediterranean Symbioses
(CIRAD, INRA, IRD, Montpellier SupAgro, UM2)
42 scientists
Director: Michel Lebrun,
lebrun@univ-montp2.fr
www.mpl.ird.fr/lstm
▶ Presentation page 30

UMR TETIS
Spatial Information and Analysis for Territories and Ecosystems
(AgroParisTech, CEMAGREF, CIRAD)
58 scientists with 10 involved in the Biodiversity topic
Director: Jean-Philippe Tonneau,
jean-philippe.tonneau@cirad.fr
http://tetis.teledetection.fr
▶ Presentation page 54

UPR AGIRs
Animal and Integrated Risk Management
(CIRAD)
22 scientists, including 10 ecologists
Director: François Roger,
françois.roger@cirad.fr
www.cirad.fr/ur/agirs
▶ Presentation page 35

UPR AMRBET
Pests and Diseases: Risk Analysis and Control
(CIRAD)
12 scientists
Director: Christian Cilas,
christian.cilas@cirad.fr
http://www.cirad.fr/en/research-operations/research-units/pests-and-diseases-risk-analysis-and-control
▶ Presentation page 32

...continued on page 63

Biodiversity *and spatialization*

Biodiversity is a key issue in many current society topics, especially those associated with the relationship between humans and nature, which in turn give rise to many environmental management questions. The joint research unit (UMR) ***Espace pour le développement*** **(ESPACE-DEV, IRD, UM2, Université Antilles-Guyane, Université de la Réunion)** is focused on promoting the sustainable development of areas, especially in tropical environments, by implementing methods for the spatialization of environmental dynamics, from data acquisition to decisionmaking processes so as to help societies in developing countries adapt to global change. The goal is to contribute to the development of environmental monitoring networks geared towards sustainable development. The expertise of the unit is utilised to build models for understanding complex systems and to generate guidelines for environmental and resource management, as well as integrated land management.

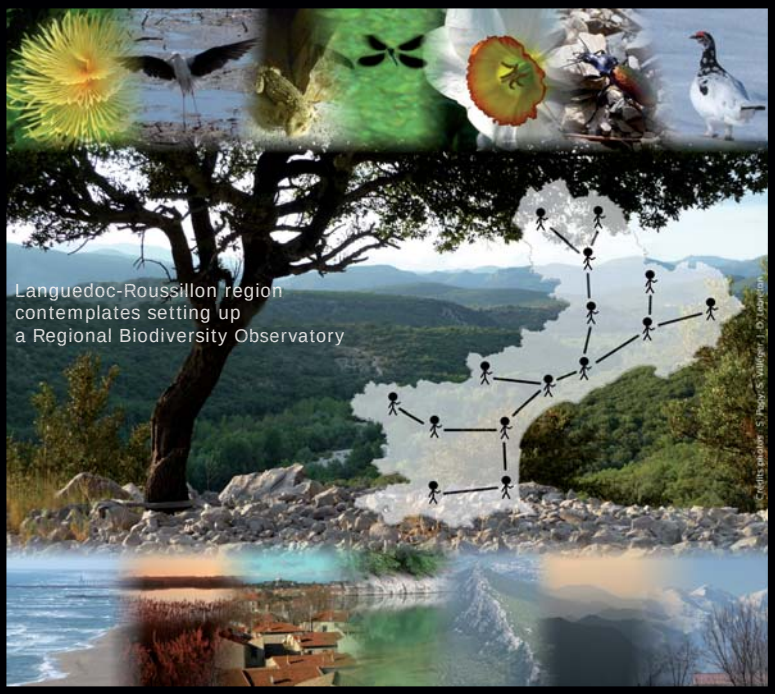
Studies carried out by UMR ESPACE-DEV (including those concerning biodiversity) readily include the spatial dimension. Satellite images of increasingly higher resolution are often tapped for these studies, making it possible:
■ to work on various scales, sometimes highly detailed, currently enabling the recognition of individuals and certain species
■ to extrapolate the results via local to regional to global upscaling
■ to gain insight into the temporal aspects through monitoring of dynamics that may be detected by image analysis.

Biodiversity is spatialized and then reinserted in its socioenvironmental setting so as to be able to understand the dynamics/interactions and to determine the impacts with respect to land management support. These different steps involve joint targeted and methodological research and require synergy between data acquisition systems and procedures (field records, remote sensing, display modes, participatory approaches), information management (databases, data storage, metadata, data sharing computer platforms), and data analysis and integration (modelling). An enhanced understanding of processes involving physical, biological sociological constituents concerning the environment is the basis of models, correlations and indicators that can improve decision-support procedures.

The multidisciplinary and complementary expertise of UMR ESPACE-DEV is encompassed within three research teams: OSE (spatial observation of the environment), AIMS (integrated approach to environments and societies) and SIC (information and knowledge system). These teams are backed by seven satellite receiving stations located worldwide (French Guiana, Réunion, Canary Islands, New Caledonia, Polynesia, Montpellier

Blueprint for a regional biodiversity observatory in Languedoc-Roussillon (France)

The 'natural heritage' action plan of the French Stratégie Nationale pour la Biodiversité includes the development of an information system on nature and landscapes (SINP), while also promoting the creation of a national biodiversity observatory and regional observatories. In Languedoc-Roussillon region (France), a study to draw up a blueprint for a future regional biodiversity observatory (ORB) was entrusted to UMR TETIS—already an SINP stakeholder in France—by the *Direction Régionale de l'Environnement, de l'Aménagement et du Territoire and the Région Languedoc-Roussillon.*


Languedoc-Roussillon region contemplates setting up a Regional Biodiversity Observatory

Languedoc-Roussillon is considered to have the highest level of biodiversity of all regions in metropolitan France, which means that it has a major responsibility in reconciling human activities with ecological considerations. In addition to its function of promoting biodiversity and pooling existing knowledge, an ORB was founded with the aim of taking biodiversity issues into greater account in decisionmaking processes and supplying elements to facilitate environmental policy assessment. The ORB must therefore come up with relevant indicators on the extent of biodiversity evolution in the region and on factors that have negative (threats) and positive (protected areas, etc.) impacts on this biodiversity.

The community of biodiversity stakeholders is especially large and diversified, which is why the study is highly participatory. The conventional information system analysis and design approach was adapted to include sustained animation while setting up a collaborative website (www.orblr.fr). At the end of this pilot experiment, an initial list of indicators will be proposed on the basis of users' needs and the regional potential. Descriptive scenarios for setting up the observatory will be proposed according to partnerships, budgetary ranges and potential types of structure. A model describing the most probable scenario will be proposed.

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& Simon Popy, simon.popy@teledetection.fr

[France] and soon Gabon). The activities are generally oriented towards regions in the developing world, where environmental and societal issues are generally serious, with the biodiversity issue often crucial. They are carried out in partnership with local teams within the framework of projects or monitoring initiatives in observatories. The main geographical areas concerned are: (1) Mediterranean/Montpellier-Africa, (2) Amazonia/French Guiana-West Indies-Brazil, (3) Indian Ocean/Réunion and (4) South Pacific/New Caledonia.

The research topics are very broad ranging, from highly targeted to highly integrative: approach oriented towards objects and biodiversity; spatialization and detection of biodiversity indicators within landscapes with the aim of setting up local observatories to monitor the environment and provide public policy support; understanding and managing existing biodiversity through the integration of environment/society data; biodiversity and environmental health; biodiversity evolution scenarios; data and knowledge sharing via the web. ■

Other teams focused on this topic

UR Tropical Forest Goods and Ecosystem Services: Facing Global Change
(CIRAD)
36 scientists
Director: Alain Billand, alain.billand@cirad.fr
www.cirad.fr/ur/bsef
▶ Presentation page 49

UR COREUS
Biocomplexité des écosystèmes coralliens de l'Indo-Pacifique
(IRD, UPMC)
21 scientists
Director: Claude Payri, claude.payri@ird.fr
www.coreus.ird.fr
▶ Presentation page 40

Software and platforms developed by Montpellier-based research units

■ *BioInfo-Biodiversité* platform supported by the federative research unit *Montpellier Environnement Biodiversité* (currently being set up).
http://mbb.univ-montp2.fr

UMR AMAP

■ *Capsis*: platform for the development of forest growth and dynamics models used for building and assessing sylviculture scenarios based on species- and region-specific models.
http://umramap.cirad.fr/amap2/logiciels_amap/index.php?page=capsis

■ *IDAO*: a tool for training young scientists and capacity enhancement with a species identification aid for biodiversity studies and information dissemination.
http://umramap.cirad.fr/amap2/logiciels_amap/index.php?page=idao

UMR CEFE

■ *E-SURGE* (with *U-CARE*) user-friendly software for population biologists: estimation and inference of species population parameters based on the analysis of capture-recapture data.
www.cefe.cnrs.fr/BIOM/logiciels.htm

■ *RMES* software: estimation of self-fertilization rates (generally inbreeding) on the basis of multilocus heterozygote distributions in population samples.
ftp://ftp.cefe.cnrs.fr/RMES

UMR CBGP

■ *DIYABC* user-friendly software: approximate Bayesian computation for population genetics inference using molecular markers.
www1.montpellier.inra.fr/CBGP/diyabc

■ *Geneland* software: landscape genetics analysis (estimation of the number of populations in a dataset, determination of the spatial organization of populations) *via* the use of geographic coordinates of individuals and multilocus genetic data.
www2.imm.dtu.dk/~gigu/Geneland

UMR ESPACE-DEV

■ *MDweb*: an open source tool for cataloging and locating information.
www.mdweb-project.org

■ *SIEL* software, an information system on local environments: monitoring and developing scenarios on the evolution of plant resources in an area according to human uses.

UMR ISEM

■ *Genepop* and *Genetix* open source software: computation of sets of parameters used commonly in population genetics and studies on their significance through exact tests and permutation tests.
Genepop: **http://kimura.univ-montp2.fr/~rousset/Genepop.htm**
Genetix: **www.genetix.univ-montp2.fr/genetix/intro.htm**

■ *Bio++* is a set of C++ libraries for bioinformatics: bioinformatic analyses, including analysis of sequences, phylogenetics, molecular evolution and population genetics.
http://biopp.univ-montp2.fr

UR Green

■ *CORMAS* platform: a multiagent simulation tool for renewable resource management.
http://cormas.cirad.fr

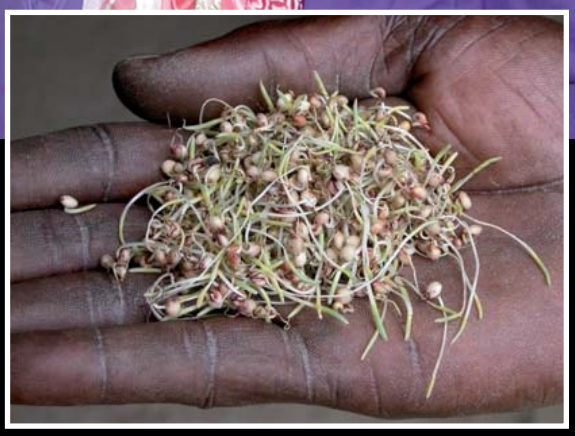
■ *MIMOSA* platform: open source software to make effective use of certain conceptual advances in the fields of modeling and computer simulation.
http://mimosa.sourceforge.net

Contact: SFR Montpellier Environnement Biodiversité, MEB@univ-montp2.fr

▲ Role-playing game with Malian farmers to discuss seed dynamics concerning farmers' sorghum varieties on a village scale.

▶ Germination of red sorghum seeds for malting prior to brewing of *dolo*, a local beer.

D. Bazile © CIRAD



D. Bazile © CIRAD

MALI—role-playing games on sorghum

Because of the extent of available food plant diversity, humans are able to tailor their cropping to prevailing and future environmental, climatic, economic and social conditions. Over a 7 year period, within the framework of the 'Sorghum agrobiodiversity in Mali and Burkina Faso' project, funded by the French Global Environment Facility, the recognised role of farmers in biodiversity preservation and creation was highly promoted. Local conditions have been taken into very little account in plant breeding programmes to date. In Mali, 90% of the sorghum seed planted is derived from on-farm propagation of traditional varieties disseminated via local seed management systems. Through participatory breeding, varietal innovations can be co-built with farmers by integrating local know-how. Research has been focused on the dynamics of varietal diversity on a village scale.

In four successive workshops involving farmers, leaders of farmers' organizations, NGOs and researchers, elements of the seed system were differentiated so that they could be separately treated so as to gain an overall understanding of farmers' choices and seed trade mechanisms. Each workshop resulted in the construction of a specific stakeholder role-playing game that can be used to analyse local practices and assess knowledge acquired previously by researchers so as to draw up the role-playing game rules.

The workshops led to the gradual development of a model of joint knowledge. Participants pointed out that the workshops helped shed light on what the researchers wanted and do. The assessment of prospective scenarios during the role-playing game sessions, or via multiagent computer simulations based on the same conceptual model, provide access to spatiotemporal scales that are not accessible in real situations. Farmers can thus monitor and discuss the impacts of their practices on varietal diversity on a village scale during several successive years, in response to events that they have previously found to be of interest.

In this specific case, solid potential areas for action emerged for setting up collective *in situ* seed management structures with the support of NGOs. It is now essential to develop other operational support tools that would be more suitable for setting up these new collective projects.

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For further information:
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