

Interdisciplinary congress

ACCAE

"Adapting to climate change: agriculture and ecosystems"



20-22 October 2010, Clermont-Ferrand



Organized by the Environmental Research Federation of Clermont-Ferrand and INRA

With the support of



ACCAE-2010 "Adapting to climate change: agriculture and ecosystems"

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- Université Blaise Pascal Clermont Ferrand II (UBP)
- Le centre INRA de Clermont-Ferrand-Theix, et les départements de recherche EFPA, EA, GAP et SAD.
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- La Ville de Clermont-Ferrand
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- Les Etablissements Vilmorin
- La Société des Eaux de Volvic
- La société Dutscher

We thanks the « office de tourisme de la Ville de Clermont-Ferrand » for the management of the congress participants accomodation.

The Local Organizing Committee wants express its gratefulness to S.Lebonvallet, the SFC du Centre INRA de Clermont-Theix-Lyon and to the staff of INRA-UREP and UBP for their skilful assistance in the organisation of this congress.

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ACCAE-2010 "Adapting to climate change: agriculture and ecosystems"

The organizing committee welcomes you to the ACCAE-2010, second congress convened by the Environmental Research Federation from Clermont-Ferrand in tandem with INRA. We hope that you enjoy the programme, but also that you have the opportunity to visit Clermont-Ferrand and the Auvergne Region.

• Congress Objectives and Ambitions

The congress is addressing the issues surrounding how agriculture and terrestrial and aquatic ecosystems are adapting to climate change. The congress will be hosted at Clermont-Ferrand from 20-22 October 2010.

The congress aims to analyse the ecological sensitivity of ecosystems and agro-ecosystems, uncertainties and impacts tied to climate change, and the adaptation efforts that need to be made, outlining progress made in this field of research. For each ecosystem or agro-ecosystem, in every sector, this analysis needs to encompass the implication for land-use practice and policy, water needs, soil quality, pathogen pressure, needs in terms of inputs and energy, the origin, quality and authenticity of farm produce, focusing specifically on the feedback effects of greenhouse gas emissions, natural resource availability, and biodiversity.

This congress will benefit from the findings of the 'ARP' forward-thinking forum 'ADAGE' (climate change adaptation in anthropogenic agriculture and ecosystems), which held its closing general assembly on 15 December 2009, providing the results of this forum and extending the conclusions to other ecosystems.

• Overview of the congress

The IPCC 4th assessment report published in 2007¹ consolidated scientific and societal opinion on the reality of climate change. Although generally speaking, it is difficult to reliably segregate the effects of global warming from a host of other factors, the impacts can be observed in cultivated or natural ecosystems, not only through phenology (for France, the bloom dates for fruit trees, the wine harvest, and corn crop seeding) but in some cases (forests) through productivity. These results emphasize that today's climate has evolved significantly since the 1940-1970 period, and evidence points to continuing change under the influence of increasing atmospheric concentrations of GHGs.

Scenario assessments for the close of the century have focused on the consequences of atmospheric CO₂ concentrations at somewhere between 540 and 950 ppm. The simulation scenarios run for the IPCC's 4th report cited an average rise in surface temperatures of 1.8 to 4°C between 1980-1999 and 2090-2099. An increase of this scale would be an unprecedented event over the last 10,000 years. In addition to these shifts in average climate figures, evidence is building that temporal and spatial climate variability and climate extremes are also increasing. The IPCC's 2007 report heralds the start of a climate future hallmarked by different configurations depending on the GHG emission scenarios. For any given socio-economic scenario (the IPCC SRES), the estimates of climate change impacts hinge on the availability of regionally-scaled climate forecasts coupling high spatial resolution with a realistic time-course variability figures on temperatures and rainfall. Furthermore, variability between climate models, regionalization methods (anomalies, statistical downscaling) and impact models only adds to the uncertainty component. These issues are compounded by the fact that current impact models have had to skirt round certain key factors, such as climate thresholds for phenology or reproduction, biotic interactions (soil biology, pathogens, etc.) and the interactions between atmospheric change (CO₂, ozone) and climate change². For those ecosystems that remain relatively unscathed by human activity, it remains exceedingly difficult to anticipate biodiversity dynamics. Finally, current modelling approaches fail to adequately integrate the spatial dynamics dimension. It is particularly difficult to assess the spatial rearrangements triggered by climate change-related patterns of migration extinction or invasion, against a complex background marked by numerous ecological pressures³ on biodiversity in ecosystems under anthropogenic pressure.

For each ecosystem or agro-ecosystem, in every sector, analysis needs to encompass a cascade of repercussions on land-use practice and policy, on water needs, on soil quality, on pathogen pressure, on needs in terms of inputs and energy, and on the origin, quality and authenticity of farm produce, focusing specifically on the feedback effects of greenhouse gas emissions, natural resource availability, and biodiversity.

Adaptation essentially looks to minimize vulnerability, and consequently stem the impacts of climate change⁴. Crop and livestock farmers, like forest managers, can already draw on a broad panel of adaptation techniques to cope with marginal changes in their current systems. Such autonomously-led shifts in practices are a logical extension of climate risk control strategies. However, at the scale of meta-systems, there are forms of adaptation that are going to require a sustained research effort spanning years and maybe even decades:

¹ "Climate Change 2007: Climate Change Impacts, Adaptations and Vulnerability, IPCC Working Group II, Cambridge University Press, Cambridge, England.

² Tubiello, F. Soussana, J.F. Howden, S. M. and Easterling W (2007). Crop and pasture response to climate change. PNAS, 104, 50, 19686-19690.

³ ESCO - Agriculture & biodiversité (2008)

⁴ ONERC, National climate change adaptation strategies.

examples include developing selected adapted genetics, engineering a decision support and alert system geared to respond to heightened climate variability, forming observatories to capitalize and consolidate adaptations in process, and so on. In straightforward terms, we need to better understand the ways farmers observe, assess and adapt their practices in response to climate change effects.

The congress will provide valuable input to this reflective analysis, and outline progress made in this field of research. The congress is platformed on **3 core sessions**:

- Session 1: **Generic approach to adaptation**: uncertainties, biodiversity dynamics, innovation
- Session 2: **Cross-disciplinary approach**: cross-tabulating biomes (crops, forests, aquatic environments, etc.), against farming sectors and geographic zones
- Session 3: **System-scale approach**: socioeconomic, environmental and territorial consequences of climate change adaptation.

Each session will feature a 'guest' address from one of the leaders of the 'ARP' forum, keynoting an international-sphere vision of the topic (an address from an international guest expert). The sessions will be illustrated by oral presentations of original as-yet-unpublished research on the target issue (the scientific committee will select 6 posters for oral communication) and a poster session presenting recent or in-process research.

The congress will also feature **four round-table debates** where discussion is open to research partners (socioeconomic actors, government agencies, local community authorities, associations). The focus areas of these debates will be:

- Funding schemes (EU, national research agency (ANR), government ministries, etc.) backing research in this field, and infrastructural resources (monitoring, trialling and modelling networks),
- Interactions between climate change adaptation and greenhouse emissions control (debate on post-Copenhagen planning),
- The food security issues involved in climate change adaptation,
- The territory-scale issues involved in climate change adaptation.

- **Laboratories actively involved in organizing the congress**

- ERF

- INRA UREP 0874, Unité de Recherche sur l'Ecosystème Prairial, 234 avenue du Brézat, 63100 Clermont-Ferrand
 - UMR CNRS 6023 LMGE : Laboratoire "Micro-organismes : Génome et Environnement" - Université Blaise Pascal. Les Cézeaux, 63177 Aubière cedex.
 - UMR INRA UBP PIAF 0547, Unité Mixte de Recherche Physique et physiologie intégratives de l'arbre fruitier et forestier, 234 avenue du Brézat, 63100 Clermont-Ferrand

PROGRAMME

ACCAE-2010 "Adapting to climate change: agriculture and ecosystems"

20 octobre

9h00 Accueil des participants

Session introductive

10h15 Ouverture du congrès
10h45 Communication Invitée : **Hervé Le Treut**
11h30 Communication Invitée : **Jean-François Soussana**, INRA
12h00 Déjeuner

Session 1 : Impacts du changement climatique

13h30 Communication Invitée : **Andreas Fischlin**, ETHZ
14h00 Communication Invitée : **Nadine Brisson**, INRA
14h30 Global warming potential from French grassland / livestock systems - **Anne Isabelle Graux**
14h45 Revue de la situation future de l'agriculture en Afrique de l'Ouest : prévision, incertitude et adaptation - **Philippe Roudier** :
15h00 Long-term effects of climate change drivers (temperature, drought and CO₂) on an upland grassland ecosystem - **Amélie Cantarel**
15h15 Within-crown microclimate, leaf temperature, leafminer moth, climate change - **Marc Saudreau**
15h30 Disentangling (separating out) the effects of human pressures and climatic change on the early life history of Atlantic salmon - **Guillaume Bal**
15h45 Pause
16h15 Présentation des posters de la session 1
17h30 Discussion
18h00 Séance posters
19h15 Cocktail
20h30 Conférence **B.Seguin** [ouverture Grand Public - Fête de la science]

21 octobre

Session 2 : Adaptation au changement climatique

8h30 Communication Invitée : **Mario Herrero**, CGIAR
9h00 Communication Invitée : **Daniel Gerdeaux**, INRA
9h30 Genetic structure and diversity of bacterial communities as affected by spatio-temporal variations of drought stress conditions in sahelian region - **Barbara Pivato**
9h45 From forest trees and stand vulnerability to extreme events to adaptive management: lessons from DRYADE national program - **Nathalie Bréda**
10h00 Framework and first results of a regional analysis of yield stagnation based on trial and weather data - **David Gouache**
10h15 Forecasting exercise on the adaptive ways of some livestock farming systems, using crop model outputs - **Jean-Christophe Moreau**
10h30 Change in recharge of aquifers under several cropping systems due to climate change. Consequences on land use at territorial level - **Bernard Itier**
10h45 Pause
11h15 Présentation des posters de la session 2
11h30 Discussion
12h00 Présentation des posters de la session 3
12h30 Déjeuner

- 14h00 Séance posters
 15h00 Tables rondes
 - 15h00-16h15 tables ronde 1 : Les enjeux en terme de sécurité alimentaire de l'adaptation au changement climatique (Animateur J.F. Soussana)
 - 16h15-16h45 Pause
 - 16h45-18h00 table ronde 2 : Les enjeux pour les territoires de l'adaptation au changement climatique (Animateur E.Josien)
 18h00 Séance posters
 20h00 Dîner en ville

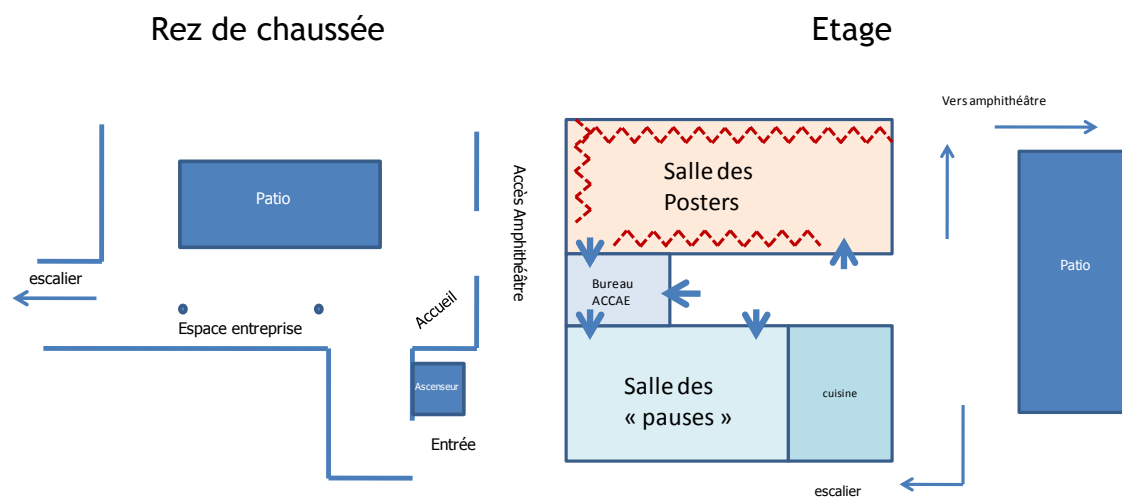
22 octobre

Session 3 : Implications à l'échelle des filières et des territoires

- 8h30 Communication Invitée : **Michael Obersteiner**, IIASA
 9h00 Communication Invitée : **Franck Lecocq**, AgroParisTech
 9h30 Characterization of climate change and its consequences on agronomic potentialities in a pastoral region - **Benoit Felten**
 9h45 Are South Indian farmers adaptable to global change? A case in an Andhra Pradesh watershed - **Stéphanie Aulong**
 10h00 Lake Chad shoreline fluctuations and their consequences for local population livelihood - **Anne Luxereau**
 10h15 Horticultural production systems and land and water resources in the Venezuelan Andes : a tenable combination ? - **Luisa Molina**
 10h30 Pause
 11h00 Impact du climat sur les rendements et les revenus : un essai d'évaluation à l'échelle européenne - **Pierre-Alain Jayet**
 11h15 Economics of Tree-Species Conversion under Climate Change Risk - **Sandrine Costa**
 11h30 Discussion
 12h15 Conclusions générales et clôture : **W. Cramer**
 12h45 Déjeuner

Les posters seront présentés en assemblée plénière dans chacune des sessions. Ils seront affichés durant tout le colloque (du 20/10 14h au 22/10 13h00).

Plan d'implantation d'ACCAE



Introductory Talk

Quelles recherches pour adapter l'agriculture et les écosystèmes anthropisés au changement climatique ? L'atelier de réflexion prospective de l'ANR « ADAGE »

Jean-François Soussana

INRA, 147, rue de l'Université, 75007 Paris.

Le changement climatique est en cours. Pour la fin du siècle, les différents scénarios évaluent les conséquences de concentrations atmosphériques en CO₂ situées en gros entre 540 et 950 ppm. L'accroissement moyen de la température de surface est estimé, d'après les simulations réalisées pour le 4^{ème} rapport du GIEC, devoir être de 1,8 à 4° C entre 1980-1999 et 2090-2099. Les prédictions sur la pluviométrie sont plus incertaines, mais elles font état en général d'une légère augmentation de la moyenne annuelle, avec une tendance à la diminution de la pluviométrie estivale dans les zones tempérées de moyenne latitude, qui serait nettement plus marquée autour du pourtour méditerranéen. En plus de ces variations de climat moyen, il est vraisemblable que le changement climatique s'accompagne d'un accroissement de la variabilité temporelle et spatiale et des extrêmes.

Même si tout doit être mis en œuvre pour éviter les dérèglements climatiques projetés (notamment par le contrôle des émissions de gaz à effet de serre), ces derniers sont probables en raison de l'inertie du système climatique et une adaptation sera nécessaire. Cette adaptation doit être envisagée comme un complément désormais indispensable aux actions d'atténuation (réduction des émissions de gaz à effet de serre).

L'adaptation au changement climatique peut se définir comme l'ensemble des actions contribuant à ajuster les systèmes naturels ou humains en réponse à des phénomènes climatiques, afin d'atténuer leurs effets néfastes ou d'exploiter leurs effets bénéfiques. En effet, le réchauffement climatique induira des coûts pour la société, mais également des opportunités qu'il s'agira de saisir.

Dans ce contexte, l'atelier de réflexion prospective de l'ANR ADAGE (www.clermont.inra.fr/adage), coordonné par l'INRA, a eu pour objectifs d'identifier les besoins en recherche et en développement sur l'adaptation au changement climatique de l'agriculture et des écosystèmes anthropisés. Le but était, d'une part, de faire émerger des priorités de recherche, en s'appuyant sur un diagnostic pluridisciplinaire ; et d'autre part, d'informer les acteurs publics et privés sur l'opportunité d'investissements dans des réseaux de suivi, dans des infrastructures ou dans des dispositifs de formation favorisant l'adaptation.

ADAGE a bénéficié de la contribution de 150 experts, issus de 43 institutions différentes et a abouti à des propositions concrètes, destinées à l'ANR, aux ministères, aux acteurs publics et privés et aux porteurs d'enjeux. Il a été organisé en trois sous-ateliers concernant :

- Les enjeux génériques de l'adaptation,
- Les enjeux par biome, par filière et par zone géographique,
- Les conséquences sociales, économiques et environnementales de l'adaptation.

Deux composantes du changement climatique peuvent être distinguées: (i) les perturbations ponctuelles liées à la variabilité du climat et aux événements extrêmes qui en découlent, (ii) la tendance d'évolution à moyen et long terme des paramètres climatiques.

S'adapter à la variabilité climatique

Avec des températures dépassant de 6°C les normales saisonnières et des déficits de pluviométrie atteignant 300 mm, la sécheresse et la canicule de l'été 2003 ont entraîné en France métropolitaine une réduction de 30 % des productions de maïs grain et de fourrages, de 25 % pour l'arboriculture fruitière et de 20 % environ pour le blé et pour d'autres productions végétales. Les dommages non assurés pour le secteur agricole ont été estimés à 4 milliards d'Euros pour la France et à 13 milliards d'Euros pour l'Europe. La productivité primaire des écosystèmes Européens a été réduite entraînant un déstockage de carbone. Cet épisode récent, ainsi que d'autres (tempête de décembre 1999, plusieurs épisodes de pluies automnales intenses, sécheresses (avec la répétition de 2003, 2004 et 2005) au cours de la décennie, démontrent le besoin d'adaptation de l'agriculture française et des écosystèmes anthropisés à la variabilité climatique actuelle. Cette vulnérabilité est encore plus importante pour l'agriculture de subsistance. Ainsi dans les régions arides de l'Afrique subsaharienne, la mortalité des cheptels nationaux a varié de 20 à 60 % au cours des sécheresses des dernières décennies. Les aléas climatiques entraînent également dans ces régions des tensions sur la sécurité alimentaire avec des conséquences négatives majeures pour les populations et pour le développement durable.

Les agriculteurs, les éleveurs ou les forestiers disposent déjà de nombreuses options techniques d'adaptation permettant des adaptations marginales des systèmes existants. Ces adaptations autonomes des pratiques s'inscrivent dans le prolongement de stratégies de maîtrise du risque climatique, qui demandent encore des efforts de recherche. Elles peuvent permettre de 'gagner du temps' pour un changement climatique modéré. Par exemple, pour les cultures annuelles, l'adaptation des pratiques agricoles permettrait d'augmenter de 10 à

20 % les rendements du blé, ce qui permettrait de retarder de plusieurs décennies les impacts du changement climatique sur la production.

Cependant, l'efficacité de cette adaptation autonome est probablement insuffisante. La mise au point de stratégies d'adaptation compatibles avec les objectifs du développement durable demeure indispensable pour limiter la vulnérabilité des sociétés et des milieux face à des changements climatiques sévères.

S'adapter au changement climatique futur

Une cascade de répercussions du changement climatique, sur les besoins et disponibilités en eau, sur la qualité des sols, sur la biodiversité, sur la pression de bio-agresseurs, sur les besoins en intrants, sur la qualité et la typicité des produits ainsi que sur les modes d'utilisation des terres est à considérer. Le changement climatique interagit avec d'autres changements et d'autres pressions sur les écosystèmes (augmentation de la concentration atmosphérique en CO₂, ozone, dépôts atmosphérique d'azote, introductions d'espèces, changement d'usage des sols et de pratiques agricoles, etc.). Il faut donc s'intéresser aux effets conjoints de ces différentes modifications dans le cadre des changements globaux. De plus, les stratégies d'adaptation généreront des externalités positives ou négatives (notamment en termes de gaz à effet de serre, de biodiversité, de ressources en eau et en sols) qu'il convient de mieux appréhender dans un contexte de tensions sur la sécurité alimentaire mondiale et de raréfaction des énergies fossiles.

Certaines formes d'adaptation nécessiteront un effort de recherche qui pourrait demander plusieurs années, voire plusieurs décennies : par exemple, création d'un matériel génétique adapté, mise au point d'un système d'alerte et d'aide à la décision en réponse à une variabilité climatique accrue, ou mise au point d'observatoires permettant de capitaliser les adaptations en cours. C'est pourquoi il est important d'engager des recherches dès maintenant sur l'adaptation au changement climatique de l'agriculture et des écosystèmes.

L'ensemble des livrables de l'atelier de réflexion prospective (ARP) de l'ANR ADAGE, ainsi que les résumés correspondant aux 15 tâches, est posté sur le site du projet (www.clermont.inra.fr/adage). Les réflexions d'ADAGE sur les enjeux de la recherche dans ce domaine ont été intégrées à la démarche de programmation de l'ANR. Cet ARP est ainsi cité dans l'appel à proposition 2010 du programme ANR 'Changements Environnementaux Planétaires et Sociétés'. L'atelier ADAGE a de plus alimenté la réflexion scientifique de l'INRA qui va lancer le méta-programme « Adaptation au Changement Climatique de l'Agriculture et de la Forêt ». Enfin, les conclusions d'ADAGE ont contribué aux propositions faites par l'INRA et le CIRAD en vue d'une initiative de programmation conjointe sur l'agriculture, la sécurité alimentaire et le changement climatique (FACCE JPI). Approuvée par le Conseil européen de compétitivité en décembre 2009, cette initiative rassemble maintenant 20 pays membres ou associés.

Session 1: The generic approach to adaptation: uncertainties, biodiversity dynamics, innovation, vulnerability

Invited papers:

Exploring the uncertainties in climate change impact studies on agriculture: results of the CLIMATOR project

Nadine Brisson (1), Denis Allard (2), Michel Déqué (3)

(1) Agroclim unit, INRA, Avignon, France

(2) Biostatistic and Spatial Processes (BioSP), INRA, Avignon, France

(3) CNRM unit, Météo France, CNRS/GAME, Toulouse, France

Introduction

Our analysis relies on modeling studies in which future climate projections are chained with agro-environmental impact models. Within this framework the word « uncertainty » has two distinct meanings: the estimation error of the calculated values and the uncertainty related to the unknown future which drives the model forcing. It is relevant to try to reduce the first one. On the contrary, the second one cannot be reduced and must be, analyzed in an exhaustive way. As a consequence two questions arise: How to account for uncertainties? How to reduce them?

The uncertainties to be accounted for are related to the prospective view of our future at various scales: global (SRES scenarios), regional (land and soil uses) and field (cropping systems, varieties, practices). It is also necessary to include the chaotic behavior of climate through the inter-annual variability.

The first types of uncertainties, to be reduced, are epistemic uncertainties due to our lack of knowledge, mathematically represented within our models. The second types of uncertainties are related to inaccurate representations of the spatial processes. This second type will not be addressed in this study.

To quantify uncertainty, IPCC recommends probabilistic approaches when it is possible. Probability density functions are not always computable. Consequently, more qualitative and gradual approaches are also proposed, based on the sign, the trend, the order of magnitude or the bounded interval. These types of calculation were performed in the project CLIMATOR. Four questions will be addressed in this study. What are the various climatic uncertainty components and their consequences on the impact? What is the weight of the epistemic uncertainties compared to other sources of uncertainty or variability and to the climate change trend? Is the impact of climate change homogeneous throughout cropping systems and French locations? What is the weight of the farmers' potential adapting practices? The first two questions will be the ones brought up in this summary.

Materials and methods

The French research project CLIMATOR (2007-2010) delivered methods and results on the impact of climate change on various cropping systems, at a field scale in 12 locations representative of the French contrasted climates (Brisson et Levrault, 2010). Results, computed by chaining climate and agronomic models, are sum up on two future periods: near future (2020-2049) and far future (2070-2099) in reference to a recent past period (1970-1999).

Uncertainty was assessed by combining in a rational way 3 SRES scenarios, 5 GCM, 2 initial states of the atmosphere, 4 downscaling methods, 2 or 3 agronomic models per cropping system, 2 genotypes per species, 3 soil types and several cropping managements (sowing dates, irrigation or planting densities).

Uncertainties were quantified by using three simple methods: "boxplot" representation, estimation and significance test of the effects in projection and analysis of variance, which allows ranking the various sources of uncertainty for a given variable.

What are the various climatic uncertainty components and their consequences on the impact?

The analysis of the weight of the various components of climate uncertainty (SRES scenarios, GCM, initialization, downscaling) on a synthetic climatic variable such as the climatic water balance (on Fig : P-ET0) or on an agricultural variable (on Fig.: wheat yield) demonstrates that downscaling methods have more influence than GCMs. The impact of the SRES scenario only appears in the far future, thus after the middle of the XXIst century. For the climate variable the trend of an increasing deficient balance appears clearly. For wheat yield, attention is mainly drawn by an increasing variability, resulting from fluctuations between positive and negative effects.

What is the weight of epistemic uncertainties compared to other sources of uncertainty or variability and to the climate change trend?

The use of several models allows to assess epistemic errors, providing intervals of variables rather than sole values. To do that, the computed values need to be comparable, i.e. coming from equivalent calculations, justifying the underneath assumption of equi-probability of the models. Thus, in the project CLIMATOR a

preliminary work was required, which aims at model convergence in terms of inputs and outputs and also in terms of the presence of processes in interaction with climate.

Once the models are comparable the numerical experimental scheme allowed performing analyses of variance. One of them is presented for the sunflower yield. Sunflower is a rainfed crop for which the effects of temperature, water and carbon (C3 plant) interfere at a high level. The analysis shows that both epistemic errors, i.e. climatic and agronomic, are of the same order of magnitude. A great part of these errors is in interaction with other sources of variability, which allows discarding the assumption of a systematic bias between the models.

When investigating the interactions between the factor « agronomic model » and the sources of variation, it appears that they are mainly related to pedoclimatic conditions, i.e. soils, locations and years.

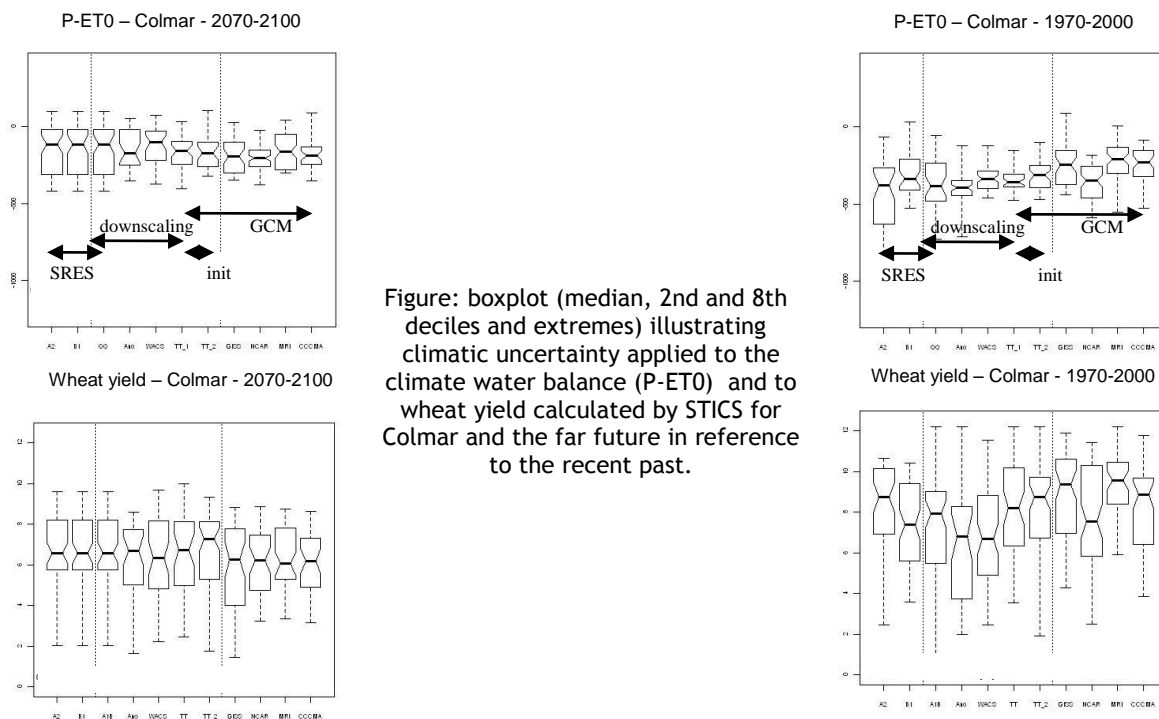


Figure: boxplot (median, 2nd and 8th deciles and extremes) illustrating climatic uncertainty applied to the climate water balance (P-ET0) and to wheat yield calculated by STICS for Colmar and the far future in reference to the recent past.

Reference

Brisson, N., Levrault, F. (Eds), 2010. "Changement climatique, agriculture et forêt en France : simulations d'impacts sur les principales espèces. Livre Vert CLIMATOR", ADEME, 334pp.

Oral communications:

Global warming potential from French grassland / livestock systems

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Grassland/livestock systems differ in their wherewithal to enhance the magnitude of GHG fluxes (CO₂, CH₄, N₂O) and their global warming potential (GWP). A simulation study was performed using the model PASIM to extrapolate potential emissions from grassland/livestock systems under alternative climate/soil/plant/management regimes at 12 French sites. Fluxes of CO₂ associated with those of N₂O indicate that both gases may be controlled by similar or concomitant environmental factors. In particular, CO₂ and N₂O fluxes were higher in the temporary grasslands, where grass management (mowing, N fertilization) promotes increased plant respiration and soil organic matter turnover. In these systems, high CO₂ and N₂O emissions were accompanied by absence of CH₄ emissions. Similar responses were observed with intensive permanent grasslands, where the presence of grazing animals also determines CH₄ emissions. High CH₄, and low CO₂ and N₂O fluxes were generally estimated with extensive permanent pastures. While there are site-to-site and climate-to-climate variations, a general conclusion is that the GWP is expected to decrease in the future as result of increased soil dryness and C stocking. Also, temporary grasslands are indicated as the most desirable land use in reducing global warming. Strategies to enhance fertilizer use efficiency, animal feed and return of animal waste could be explored as adaptation/mitigation measures.

Keywords : Climate change; GHG; Grassland; PASIM

Revue de la situation future de l'agriculture en Afrique de l'Ouest : prévision, incertitude et adaptation

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Impact studies concerning the impact of climate change on agricultural yields and/or production are getting much more frequent: it is therefore important to review all these studies to have a global view of the possible changes, and not to focus only on one value. We choose West Africa because agricultural systems in this region are very vulnerable to climate change and because this area is a main one in African agricultural production. Moreover, the results (in official reports...) generally do not focus on African sub-regions. We first study the different methodologies used in the literature and their parameters (considering about 20 papers). Second, we give their results about future crop productivity crop by crop and in aggregate and third, we evaluate the uncertainty driven by each parameter (crop model, climate model, carbon fertilization...), as assessment of uncertainty in such predictions is now a key point in impact studies. We also underline how the authors consider adaptation: Ricardian analyses include a perfect and costless adaptation, while the others take into account no or few adaptation strategies. The former assumption leads to an underestimation of the damages, and vice-versa for the latter assumption.

Key-words : Afrique, rendement, prevision, revue

Long-term effects of climate change drivers (temperature, drought and CO2) on an upland grassland ecosystem

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Climate change is predicted to have significant impacts on plant community structure, diversity and soil processes, with cascading effects on ecosystem function and greenhouse gas emissions. We used a grassland ecosystem manipulation experiment to investigate the responses of plant community dynamics, plant functional traits and N₂O fluxes to the climate scenario forecast for 2080 in central France (IPCC scenario A2). The additive experimental design applied an increase in temperature (+ 3.5 °C), a decrease in summer rainfall (-20 %), and an increase in atmospheric CO₂ concentration (+ 200ppm) on grassland monoliths in situ during a five year study. We found that elevated temperature was associated with a long-term decrease in annual aboveground biomass. Indicators of grassland structure and function differed in their sensitivity to climate change treatments ; aboveground biomass and plant traits showed pronounced and rapid responses to climate drivers whereas plant diversity showed little response to climate treatments during the study. In general, elevated temperature had a positive effect on N₂O fluxes. Across climate treatments, N₂O fluxes were correlated with soil temperature, water soil content and rainfall but climate treatments appeared to modify the relationship between N₂O fluxes and abiotic factors

Key-words : Climate change, plant community structure, N2O fluxes

A biophysical approach to simulate effects of climatic change on tree pest insects

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During the 21st century, agriculture, horticulture and forestry would face an increase of the annual generation number of pest insects with serious economic losses as a consequence of the global climate change (IPCC 2007). In this context and because pest developments are strongly linked with its host plant, biophysical models coupling the host plant physiology, the pest development and climatic change scenario are promising tools to simulate and make predictions on potential pest development. In this study such coupling was done for apple trees, a leaf-mining moth, *Phyllonorycter blancardella* (Lepidoptera: Gracillariidae), and a medium emission climate change scenario according to the IPPC

This survey confirms that as the century continues to unfold the development time of *P. blancardella* caterpillars at the fifth larval instar will decrease. However the use of our integrative model provides substantially more information since the hourly dynamics of all larvae within tree canopy are simulated. Thus, from a quantitative point of view, it appears that tree architecture has an impact on insect development time

and insect mortality. Such integrative model is than a relevant tool for estimating what kind of tree architecture management is suitable or not to reduce pest development

Key-words : Within-crown microclimate, leaf temperature, leafminer moth, climate change

Disentangling the effects of human pressures and climatic change on the early life history of Atlantic salmon)

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Disentangling the relative effects of anthropogenic perturbations acting at different scales is of critical importance to improve ecosystem management. This question is addressed through the analysis of the factors affecting the early growth of Atlantic salmon in the wild, as this life history trait conditions the whole demographic and the population dynamics features. The Mean Age at Smoltification (MAS) is negatively correlated with early juvenile growth rate. Time variations in the MAS in salmon populations of the Armorica Massif from 1972 to 2005 combined a long-term decreasing trend over the period with medium-term fluctuations that are synchronous among rivers, suggesting a response to climatic trends at a regional scale. Temporal change in juvenile growth was then investigated at the scale of the Scorff River. Length of one year juvenile increased over the period and was positively correlated with the temperature during the early growth period, but also with nitrate concentration and negatively correlated with fish density. Stable isotope analyses on scales of juveniles collected in the Scorff R. also revealed an increase of ^{13}C during the same period. Taken together, these results suggest an increase of the juveniles growth rate, but the relative effect of climatic changes and local disturbances upon early growth might be hard to separate out

Key-words : Atlantic salmon, Life history, Human pressures, climatic changes

Posters

S1-1 Impacts of climate change combined with a summer extreme events on perennial grassland: a new experiment in the Ecotron of Montpellier

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Summer heat waves affected grassland ecosystems production. In France during 2003, forage production of grasslands decreased by 40% associated with a decrease in soil carbon (Ciais et al 2005). Responses of grassland ecosystems to such extreme events are not well studied and models are not able to properly simulate ecosystems responses. In this context, we started an experiment profiting by the macrocosm platform of European Ecotron in Montpellier with the aim to study responses of perennial grassland to climate change combined to summer extreme events (ANR VALIDATE). For this purpose, $1m^2 \times 0.6 m$ monoliths of grassland are exposed to a future climate scenario (2040-2060) corresponding to an increase of $2^\circ C$ air temperature and of $520 \mu mol mol^{-1}$ in CO_2 concentration compared to the actual conditions. Main ecosystem processes such as gross photosynthesis, respiration and evapotranspiration are measured at daily rate through canopy gas exchange. Below-ground net primary production, soil and root respiration are also assessed, together with an estimation of botanical composition. Results will assess if elevated CO_2 could mitigate the negative effects of summer drought and warming. Opened questions for this experiment are the following: Does botanical composition of grassland will be modified in this context? Does the recovery of main services, such as production of forage and its quality will be achieved once the heat wave effect is over?

Key-words: above-below-ground production, drought, elevated CO_2 , air warming.

S1-2 Impacts of compost amendment and seasonal differences in soil moisture and temperature on microbial community in a Mediterranean soil

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Climate models predict higher air temperature and less frequent, but larger precipitation events. These events may impact the soil functions. Moreover, production of biosolid wastes such as compost is increasing and waste management becomes more crucial. The amendment of soils with composts is an alternative for improving soil fertility and also for reducing waste disposal costs. In the current Mediterranean context, fewer studies have

focused on the interaction of seasonal shifts and organic amendments on soil microbial community. In this work, we studied the impacts of inputs of urban waste compost in situ on the activities of microbial communities under actual Mediterranean climate. The compost was added on October 2009 at the recommended dosage. Temperature, humidity of soils (control soil and soil with compost) and functional diversity of microbial community are monitoring along the year. The physiological profile of the community is determining by MicroResp analysis. The first results showed that compost amendment affected the activity of the soil microbial community. In addition, this change in the microbial function is also affected by seasonal temperature and precipitation.

Key-words : Seasonal variation, compost amendment, microbial communities

S1-3 Effets d'événements climatiques extrêmes de type canicule/sécheresse sur les communautés microbiennes des sols agricoles méditerranéens

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An experimental study was undertaken to identify the impacts of severe drought and high temperatures on the microbial community of an agricultural soil, and particularly to shed light on the microbial long-term effects of such perturbations caused by heat waves. Two experiments were performed: one mimicking heat waves with different durations and a second one mimicking a severe drought followed by a heat wave. Soils were sampled and analyzed just before and after induced stresses, and at intervals until the end of the experiment. In terms of both resilience and resistance, drying-heating generally had a stronger effect than drying (drought stress) on soil microbial parameters (biomass, activity, functional structure (CLPPs) and taxonomic structure (EL-FAMES)). Stress duration had significant effects on the microbial parameters investigated. In the cases of long-duration heat-wave stresses, we observed no resilience after restoring initial environmental conditions. The stress seemed to have a lasting effect on some microbial parameters. The restructuring of the microbial communities over the course of the experiment may be a consequence of drastic inhibition of sensitive species and selection of tolerant species by the stresses applied, but also of the proliferation of fast growing species after the environmental soil conditions had been restored. Heat wave stress had less impact on microbial parameters of soils previously exposed to drought stress. This may be an indirect result of "stress-induced community tolerance"

Key-words: canicule/sécheresse, communautés microbiennes, sol

S1-4 Estimating ozone impacts on wheat physiology and yield under a changing climate

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Ozone is a phytotoxic air pollutant, due to strong oxidizing properties. In a changing climate perspective, the increase of surface-level ozone concentrations observed in the industrialized countries may reduce the carbon sink strength of vegetation under the increasing atmospheric CO₂ level.

Results of several years of ozone fumigation experiments on wheat at the field level indicate a strong potential impact of this air pollutant on the functioning and yield of wheat. Several types of dose-response functions were established from these results in order to calculate ozone impacts on wheat stomatal conductance, photosynthesis and yield. In the frame of the VULNOZ ANR project, estimations of the impacts of ozone on wheat calculated by means of these dose-response functions were compared at the regional scale (Ile-de-France) over an 18 years period (1992-2009). The results show that climate changes may affect significantly the response of wheat to high ozone concentrations. This study outlines the need of more precise models taking into account the detoxifying properties of leaves, one of the main objectives of the VULNOZ project

Key-words : Ozone - risk assessment - wheat - regional scale

S1-5 Vulnerability to ozone in anthropized ecosystems. Which risks for 2020-2030? Results from the Vulnoz project in maize crops.

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Ozone (O₃) is an important gaseous air pollutant with phytotoxic effects due to strong oxidizing properties. The tropospheric ozone concentrations have become a factor of climate change tending to mitigate the carbon sink strength of vegetation under the increasing atmospheric CO₂ level especially in spring and summer as shown by the 2003 heat wave. The VULNOZ, ANR project (2009-2012), aims at improving knowledge on basic plant response mechanisms to ozone (2009-10) in order to integrate them in global ozone impact prediction models suitable for economic risk assessment (2011-12). Here, we will focus on results about vulnerability of maize, a representative summer crop. Experiments were carried out using a new field O₃ enrichment device (on maize field). The quantification of the ozone fluxes between the atmosphere and the canopy and its partition between stomatal and non-stomatal parts were achieved in Grignon, Bordeaux and Toulouse. O₃ leaf photosynthesis impacts obtained in Open Top Chambers and in growth chamber were analysed by a model of C₄ leaf photosynthesis. Risk assessment indicators were compared: AOT40, an O₃ hazard indicator, and Phytotoxic Ozone Dose (POD) which indicates the uptake of ozone within the leaf. These results are the first step to introduce the detoxification capacity in regional O₃ uptake models, in order to better take into account ozone impact on agroecosystems when background ozone concentrations increase.

Key-words: Ozone - risk assessment - maize - stomatal conductance

ANR-VULNS 012, Projet Vulnoz (Vulnerability to ozone in anthropized ecosystems. Which risks for 2020-2030 ?)

S1-6 Optimization of endodormancy release models, using a long serie of endodormancy release data collected in France.

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In fruit tree species, evaluation of models of endodormancy release has generally been indirect, as part of the global evaluation of budbreak-date models that include an endodormancy release module. Due to the lack of data, their direct evaluation has been very succinct. Consequently, they have not been optimized, except for the 'amount of chill units required to break endodormancy' taken as the genotype specific parameter. So, they seem inaccurate for testing the consequences of winter global change scenarii. Based on the biological 'one node cuttings' test under standard conditions (25°C), near 30 yearly dynamics of the dormancy state were used to optimize classical models (Weinberger-W; Utah-U; Bidabé-B; Dynamic-D ...) of endodormancy release on peach vegetative buds response. The temperature was the only input variable to compare their fitness and their predictive capacity. The fitted parameters were the 'amount of chill units required to break endodormancy', those of the temperature functions f(T) describing the rate of endodormancy development and, for some models, the starting date of endodormancy release. As main results: (i) negative temperatures seem to be effective for endodormancy release; (ii) the optimization resulted in an increase of the standard threshold temperature; (iii) the transition from positive to negative effect of temperature is sharp

Key-words : Bourgeons, arbres, dormance, débourrement-floraison

S1-7 Aerobic and anaerobic methane oxidation in the pelagic zone of a meromictic lake (lake Pavin, Auvergne).

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The results presented recap findings from collaborative research conducted through cross-disciplinary projects (EC2CO METHANOLAC and INTERLAC; CPER environnement).

The deep water layer (60 to 92 m depth) of Lake Pavin is permanently anoxic (meromicticity). Even if high amount of methane are produced at sediment surface, this metabolite is almost not detectable at the oxic/anoxic interface at 60 m depth. Reactive transport modelling of methane suggests the coexistence of aerobic and anaerobic methanotrophic activities in the water column. In order to identify microorganisms involved in these processes and to understand which factors regulate their activity, culture-dependent and independent approaches were used. PmoA and 16SrRNA gene amplifications revealed a large vertical

distribution of the aerobic methanotrophic community as these genes were detected between 20 and 75 m depth. This community is composed of the three major phylogenetic groups of aerobic methanotrophs (type I, II and X) and dominated by the genus *Methylobacter* (type I). Activity of this genus was detected by RT-PCR of *pmoA* until 65 m depth where oxygen concentration is below the detection limit. Several strains of aerobic methanotrophic bacteria were isolated and identified as *Methylocystis echinoides*. Anaerobic methane oxidation was investigated by microcalorimetry : water samples from anoxic layer were incubated under N₂ or CH₄ gas phase. The highest amount of heat released by samples incubated under methane phase supports the hypothesis of the anaerobic methane oxidation in Lake Pavin.

Key-words : Limnology, Methanotrophy, Molecular ecology, Microcalorimetry

S1-8 Study of the impact of climate change on disease dynamic through the development of a model of pathogens coupled with the STICS crop model

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It is crucial to evaluate the consequences of climate change on the occurrence and the development of crop diseases in France. Taking into account the multiple interactions between climate, crop and disease would enable to consider both direct climatic effects on pathogen development and indirect effects through crop structure and microclimate. Generic models coupling pathogen development and crop growth may be relevant tools for exploring such questions. In order to develop a model of pathogen development to be coupled with the STICS crop model, we identified the relevant epidemiological processes (infection, sporulation, etc...) and we analyzed the pathogens responses to climatic, microclimatic and plant variables (e.g. plant age). A common modeling structure was developed to account for the various types of pathogen responses that were identified for each epidemiological process. Response functions adapted to each type of pathogen response were found, the parameters of them being proper to the fungus specie and having a biological significance. These functions were validated by comparing simulated results with experimental data. For instance, the function describing infection according to wetness duration and temperature was tested on six pathogens giving a maximal error of 20%. This model is suited for analyzing the effect of climate change on the epidemiological processes in combination with plant processes and understanding their impact on disease development.

Keywords : climate change, disease development, model

S1-9 How is cold acclimation possible with warmer autumns?

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Models gauging the effects of climate changes on the cold acclimation process in trees need to consider the effect of autumn temperature changes. Since these models predict an increase in autumn temperature, we ran different treatments to test the effects on cold acclimation potential. Two-year-old walnuts were defoliated at two different dates, i.e. mechanical defoliation in early October (Early leaf Fall, EF) or natural defoliation in early November (Late leaf Fall, LF) and conditioned in either cold or cold-deprived (min. air temp. >13°C) greenhouses over winter. EF treatment, by stopping transpiration, significantly increased tree water content and, at warm temperature, high root activity stopped normal winter dehydration. Starch content decreased in all treatments, but there was only a significant increase in soluble carbohydrate content when water content had decreased sufficiently. Thus, depending on date of defoliation, cold-deprived trees were or not able to acclimatize to frost (minimal LT50 = -21.8°C vs -22.1°C in controls for LF and -13.7°C vs -25.3°C in controls for EF). The cold acclimation process appeared dependent not only on temperature change but also on the interaction between two key physiological parameters, i.e. water and soluble carbohydrate content). Thus, in future, predictive models on the impacts of climate change on tree survival and the geographic distribution of woody plants need to take these parameters into account

Key-words: Winter biology of trees, frost resistance, global change

S1-10 Biomécanique du soutien et stratégies de croissance en hauteur des plantes : contraintes environnementales, processus régulateurs et traits

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For their survival, plants need to grow in height to access light resource while ensuring their mechanical stability. Growth in height amplifies the mechanical constraints due to wind and gravity. But plants sense these constraints as morphogenetic signals to which they respond by modifying their growth. There are two processes of growth regulation by mechanical signals: thigmomorphogenesis and gravitropism. Thigmomorphogenesis involves a reduction of growth in height and an increase of growth in girth under the effect of mechanical signals. This is a way for plants to grow with controlling slenderness of their axes to avoid mechanical damages. In some cases (storm, sudden exposure to a new mechanical environment) this process is not sufficient to prevent lodging, gravitropism then acts to restore axes orientation (as long as the damages are not lethal). With measuring several traits, we have demonstrated that these processes have a fundamental ecological role in the control of tree habit and the vertical structuration of ecosystems. As studies of climate changes seem to predict a higher frequency of storms the diversity of their efficiency observed in plant communities is an important issue.

Key-words: Biomechanics, gravitropism, thigmomorphogenesis, wind

S1-11 Microbial communities adaptation induced by global change

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An overwhelming majority of life on our planet is microbial, both in terms of phylogenetic diversity and sheer numbers of organisms. Virtually every conceivable environmental niche harbours the growth of microorganisms. Microbial diversity largely contributes to the functioning of ecosystems. An outstanding challenge in microbial ecology is to understand the microbial adaptation mechanisms to various disturbances including climate change.

Nowadays, human activities are the cause of various climate disruptions leading to a progressive modification and vulnerability of many ecosystems. The knowledge and the evaluation of these modifications on microbial communities of various ecosystems such as soils, will contribute to a better understanding regarding the preservation and restoration of such ecosystems.

New molecular tools based on metagenomic approach enable to explore the complete microbial diversity as well the identification of micro-organisms adaptation mechanisms to particular stress.

We report the development of a large fragment capture method of nucleic acids using DNA microarrays. This new method will help us to link microbial structure modifications to functional capacity adaptations in the context of global change.

Key-words : ecosystems, global change, microbial communities, gene capture

S1-12 Analysis of the genetic determinism of phenological traits on Prunus fruit species and its interaction with environmental and climatic conditions

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Within tree fruit species, increasing evidence shows that advances in blooming dates, as well as phenological disorders, can be linked to temperature increases during periods of dormancy (autumn, winter) and bud burst (spring). To anticipate these negative effects, an innovative project was initiated on sweet cherry (*Prunus avium*) at UREF (INRA Bordeaux). The main objective was to decipher the genetic determinism of blooming date in order to incorporate this information in marker-assisted breeding programmes. An integrated and multi-disciplinary approach (genetics, genomics and ecophysiological modelling) was adopted. Using a sweet cherry progeny, QTLs for blooming date were detected and their positions were compared with those identified in genetic maps derived from four additional *Prunus* (peach and apricot) progenies evaluated during four to eight years to test the QTL stability and to explore the extent of synteny for this trait within the genus.

Moreover, the decomposition of blooming date into chilling and heat requirements was initiated in 2010 in sweet cherry. The environmental effect on the QTLs detected will be evaluated at three different European sites with contrasting climates: oceanic (Bordeaux, France), Mediterranean (Nîmes, France) and continental (Maribor, Slovenia). Finally, a candidate gene approach will be undertaken in sweet cherry by developing EST resources at different phenological stages in order to conduct transcriptomic analyses.

Key-words: Prunus, sweet cherry, blooming date, chilling and heat requirements

S1-13 Adapting grapevine varieties to climate change: can the genetic variability meet the challenge?

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Climate change is expected to advance grapevine phenological stages. Using a degree-days model, we were able to simulate dates of budbreak, flowering and véraison for Riesling and Gewurztraminer, two winegrape varieties grown in Alsace, France. Projected daily temperatures were calculated for the Colmar meteorological station with the ARPEGE-Climat general circulation model using three distinct greenhouse gas emissions scenarios. Compared with its timing in 1976-2008, véraison is predicted to advance by up to 23 days and mean temperatures during the 35 days following véraison are projected to increase by more than 7°C by the end of the twenty-first century for both varieties. Such changes will likely have a significant impact on grape and wine quality. Using the same framework, the genetic variability of phenological parameters was explored with 120 genotypes of progeny from a Riesling x Gewurztraminer cross, along with 14 European varieties. In addition, we created a virtual late ripening genotype, derived from a cross between Riesling and Gewurztraminer. This modelled genotype was projected to undergo véraison 2-3 days before Muscat of Alexandria, one of the latest ripening varieties studied. Even with this virtual genotype, or with Muscat of Alexandria, grapes would ripen by the middle of the twenty-first century under higher temperatures than in the present years.

Key-words: Grapevine, genetic variability, phenology

S1-14 Potential impacts of climate change on grassland productivity at French sites

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Given the recognized importance of grasslands to the global carbon budget, a simulation study was performed using the model PASIM to extrapolate potential impacts of altered climate regimes on grassland resources. An array of scenarios was sketched to be representative of climate/soil/plant/management interactions at 12 French sites. SRES climate change projections for near (2020-2049) and far (2070-2099) future were constructed using a range of climate models and settings which mark the limits of uncertainty associated with current climate modelling. PASIM was employed to generate a variety of outputs related to biomass productivity and C budget. Based on alternative scenarios, air temperature rise by -1-4 °C to the end of 21st century, combined with increasing CO₂ levels, translates into increased yields although generally accompanied by decreased precipitations. The latter is likely the main cause of the larger variability of yield observed from year to year under modified climate. A more complex response was observed for spatial and temporal variation of soil organic C. The risk of general driest conditions associated with climate change may not be reflected in yield and C losses due to concurrent effects of increased atmospheric CO₂ concentrations, but calls for consideration of water resources depletion. Margins for adaptations can be explored in terms of crop management (e.g., effects of different cutting dates or grazing periods).

Key-words : Climate change; Grassland; PASIM

S1-15 Cold resistance evaluation in different species and provenances of Juglans sp.

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Juglans regia is known for its valuable timber. One of the main problems of *J. regia* is its vulnerability to low temperatures, mainly the Mediterranean provenances; this problem would be increased according climate change estimations. The main objectives of the present study were to assess the level of the cold resistance of different *Juglans* species and provenances (populations) from distinct climatic and agronomic conditions. Also,

it would be compared different methods for evaluation low temperature effects on this kind of plant material. Budsticks from clones and seedlings, collected at leaf fall, were submitted to freezing range of temperatures between +5 to -15°C. Electrolyte leakage (EL) was analyzed on stem slices. Visual damages and Fv/Fm of the cambium were evaluated on budsticks two weeks after stress treatment and maintained under high humidity environment. Plant material used was two Spanish clones of *J. regia* and black walnut, one of *Jxintermedia*, and seedlings from four Spanish provenance regions of *J.regia*. Black walnut clones were the most cold resistant, *J. regia* clones the least, and the hybrid was in the middle, as we expected. All provenances showed similar response until -5°C. Influence of the planting site was observed (NE vs. NW of Spain), making significant the interaction between site & provenance origin. A good correlation between different methods tested for evaluation was found; consequently Fv/FM ratio seems to be a useful method, because of its ease and speed.

Keywords : walnut, genetics, stress resistance.

S1-16 Production flexibility in extensive beef farming systems: which roads face to droughts?

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The aim of this work is to assess the flexibility of production allowed by extensive production conditions faced with market variations and climate fluctuations of Limousine beef systems. The study used a case-based methodology in which seven beef farms with less than 1 LU/ha were chosen. Data collection was based on three interviews using a semi-structured questionnaire and on the analysis of productive and economic results over a 15-year period (1991-2005). The main evolution of these farms is related to a rise in work productivity associated with an increase in herd size. To take advantage of the enlarged land area, females were reared for fattening or for reproduction instead of selling them at weaning. The Limousine female provides a wide product mix because of its plasticity, as has been studied by several researchers. This mix flexibility is achieved by delaying product differentiation, a form of production flexibility that can reduce the risk of under producing or over producing varied product configurations. On the other hand, calves sold to the Italian market after weaning are generic products, associated with a flexible production process to overcome fluctuations in forage availability due to climate variations. The introduction of maize silage for feeding acts as an alternative route (actual and potential) through the system to overcome unexpected forage shortage from natural grasslands as a result of droughts

Key-words: extensive farming system, livestock production system, mix flexibility, process flexibility

S1-17 Impact of agricultural practises and climatic variability on carbon storage of grazed grassland

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In the current context of climate change, intra- and inter-annual variability of precipitation can lead to major modifications of grassland production and carbon storage capacity (Nagy and al. 2007). A better insight on how climatic variability affects net carbon exchange (i.e. NEE) of grazed grasslands are, thus, important to prevent from extremes events and increasing greenhouse gas emissions. Since 2002, we measured continuously NEE (eddy covariance technique) on an upland grassland site (7ha), divided in two paddocks grazed by heifers (intensive: 1 LSU/ha/year, 213 kg N/ha/year and extensive: 0.5 LSU/ha/year, no fertilization). Continuous measurements allowed comparing “normal” and dry years (2003 and 2005) in relation to agricultural practices. Results show, that during dry summer years, the extensively grazed paddock stores less carbon (smaller cumulated NEE) than both, other years and the intensive paddock. This could be assigned to a decline of gross primary production (GPP) and an increase of ecosystem respiration (Reco) compared to “normal” years. In dry-summer years, the intensive paddock shows a slight decline in both, GPP and Reco. In those summers periods (week 20-35), precipitation sums were <100mm and soil water stocks decreased until a critical threshold. This led to a decrease in evapotranspiration, an increase of sensible heat and a switch to respiration in the extensive paddock. This partly explains the fact that in 2003, 2005 and 2008 the intensive paddock stored more carbon than the extensive. These results demonstrate that grassland subjected to a moderately intensive management may have a higher carbon storage potential during drought or heat wave, supposedly due to a regulation in evapotranspiration. However, N₂O emissions are likely to be more important in the intensive paddock which worsens net greenhouse gas balance

Key-words : Latent and sensible heats, NEE, grassland

S1-18 Vulnerability to ozone in anthropized ecosystems. Which risks for 2020-2030? (Vulnoz project)

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In industrialized countries, ozone (O₃) is an important gaseous air pollutant with phytotoxic effects due to strong oxidizing properties. The elevated surface-level ozone concentrations have become a factor of climate change tending to mitigate the carbon sink strength of vegetation under the increasing atmospheric CO₂ level. An increased vulnerability of agroecosystems could occur. The partners in VULNOZ, ANR project, aim at improving knowledge on basic plant response mechanisms to ozone in order to integrate them in global ozone impact prediction models (at regional scales) suitable for economic risk assessment. Here, we will present first results about :

- the impact of ozone on cell and leaf functioning and study of the detoxification capacity of the plants (on wheat and poplar trees, phytotron studies)
- the quantification of the ozone fluxes between the atmosphere and the canopy, its partition between stomatal and non-stomatal parts (on maize field)
- the development and evaluation of ozone-impact models in photosynthesis and plant growth models (on wheat, fumigation in field).

Key-words : Ozone - risk assessment - forest - agronomy

ANR-VULNS 012, Projet Vulnoz (Vulnerability to ozone in anthropized ecosystems. Which risks for 2020-2030 ?)

S1-19 Drought insurance for millet growers in Niamey area: ex-ante evaluation of potential interest to farmers and risk faced by the insurer

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In West Africa, crop yields depend on rainy season characteristics and fields are very rarely irrigated, increasing farmers' vulnerability to a bad rainy season. We will discuss in this article what is at stake in order to insure yields against drought in the particular case of Sahelian climate. The papers try to draw the risk mitigation capacity of rainfall index insurance in the particular case of Sahelian climate. The context of high spatial variability of precipitations indeed creates a pooling potential that could

be turn such safety nets program implementation into poverty alleviation. We test the robustness of insurance gain for farmers to index choice, using different indicators of farm yield distribution and well-being. The gain of implementing insurance is not negligible even for a crop that is known to be resistant to drought when there is substantial risk aversion. On the other hand, overall insurance gain seems limited by the high basis risk that lies in the high occurrence of non-water related damage. More than that, the significance of insurance gain, inquired at the plot level, is also threatened by out-of-sample estimation (we run here a leave-one-out method) inducing losses either for growers or the insurance organism, in the short and the long run.

Key-words : Crop insurance, meteorological index, agriculture.

S1-20 Implication des aquaporines dans la régulation de la conductance hydraulique foliaire chez le Peuplier

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Agriculture is facing up new environmental constraints associated with climate change and in particular related to water availability. Today's challenge consists in selecting and developing future crops being productive while limiting their water consumption. For C3 plants, even a moderate water stress will lead to stomata closure, thus decreasing photosynthetic activity. In order to limit detrimental effects linked to water column breakage, plants permanently adjust their hydraulic resistances. Within factors known to influence those resistances, the aquaporins (AQPs) might have a central role. AQPs are proteins acting as pores that selectively allow small solutes to flow through cell membranes. Indeed, the over expression of AQPs belonging to Plasma

membrane Intrinsic Protein (PIP) family is associated with growth, photosynthesis and water transport increasing under certain conditions. Hence, we hypothesize that PIPs activity is associated with plant Water Use Efficiency (WUE). Our work aims at characterizing leaf hydraulic conductance (Kleaf) using High Pressure Flow Meter (HPFM) method and identifying PIPs implicated in the Kleaf regulation by monitoring gene expression using Quantitative PCR in plant tree model: Poplar. Results obtained on Poplar show a leaf hydraulic resistance decrease in parallel with PIP genes up regulation under high irradiance

Key-words : Aquaporines, Peuplier, WUE, Kleaf

S1-21 Impact de la prolifération des sachets plastiques sur l'environnement urbain de Yaoundé

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The proliferation of plastic sachets (bags) and their careless disposal by their users on the environment constitute one of the most important forms of visual and environmental pollution in the towns of Cameroon. This poses an urgent and justified demand for intervention (justified by reports and relays from environmental actors and observers, and urgent in relation to the damages and harm which continue to be inflicted on the Cameroonian resources). The objective of this study is to contribute to the preservation of vital resources in the Yaoundé town through the establishment of conditions and the identification of alternative solutions or appropriate and sustainable substitutions. The execution period will be from June to September 2010, and the methodology will include subsequent phases of; Documentary research, Collection of information, Examining and Analysing, and finally, Editing. The phase on Field Work will be focused on Direct Observation and will include exchanges with the decision-makers. The expected results include: A diagnostic of the environmental risks incurred the ecosystem as a whole, on the landscape and the human community; Formulation of propositions on good practices; Formulation of alternative propositions on the ban/abandoning of the use of plastic sachets and the replacement of this material.

Key-words : Ecosystème; Environnement humain, urbanisation, Ordures ménagères

S1-22 Soil vulnerability in Sahel: coupling microbiological, physical, chemical, and sociological assessments

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The SolAO project aims answering essential questions about soil ecosystem vulnerability in West African arid areas (Senegal). We considered farming soils as model objects under climatic and anthropogenic pressures, taking into account chemical and physical soil properties and their bacterial communities, and also description of soils and of their evolution by farmers. We addressed the bacterial adaptation to edaphic environment both on the population diversity and functioning points of view, with respect to potential changes in soil parameters, and the human perceptions (rural communities) of the quality and future evolution of their soils in a changing environment. The sociologic aspects also included the knowledge and current practices associated with their soil perception in cultivated areas. This study referred to an institutional framework for collaborative exchanges and work between rural communities and researchers. This partnership involved people expecting useful data on soil vulnerability in arid countries, especially concerning farming soils they are closely related and dependent on.

Key-words : Environmental changes ; arid soils ; bacterial adaptation ; partnership farmers - scientists

ANR VMCS, projet SolAO « Involvement of the bacterial communities in the vulnerability of the Sahelian soils: biological, physicochemical and social approaches »

S1-23 Effects of climate change and of soil decomposers on root decomposition

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Plant litter decomposition plays a major role in carbon and nutrients cycles of terrestrial ecosystems. In grassland, root decomposition corresponds to the main C and nutrient inputs into the soil. Changes of climate

conditions, litter quality and diversity of microbes and micro fauna decomposers are key actors of organic matter decomposition. We report the impacts of future climate scenario (+3.5°C, -20% summer precipitations, +200ppm atmospheric CO₂) and of decomposers communities on the rate of root decomposition. With the same initial litter quality, we test the hypothesis that root decomposition is controlled by both direct (change of decomposers communities, rhizospheric activity) and indirect (climate change) effects. Root litter bags were incubated for one year in monoliths of grassland exposed to four climate treatments (C=Control, T=Temperature, TD=temperature + summer drought, TDCO₂=temperature + summer drought + elevated atmospheric CO₂). Three mesh bags were used to compare the specific effects of bacteria (5µm), of fungi+bacteria (50µm), and of fungi+bacteria+micro fauna (1000µm). Whatever the mesh of the litter bag, increase of air temperature accelerated the decomposition. Increasing atmospheric CO₂ concentration induced also higher rate of decomposition due to increase of rhizospheric activity (rhizodéposition, respiration). Furthermore, our results suggest that decomposer groups are differentially affected by climate change through a combination of direct and indirect effects.

Key-words : air warming, summer drought, elevated atmospheric CO₂, root composition

S1-24 THERMODYNAMIC STUDY OF CO₂ CAPTURE USING CHEMICAL ABSORBENT

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Carbon dioxide is considerate as the main green house gas, responsible for global warming. The anthropogenic emissions of carbon dioxide represent about 70% of the total effect. One of the options to fight against this environmental problem is to reduce CO₂ emissions in industrial effluents.

Industrial processes to remove CO₂ from gas stream consist in repeated cycles with dissolution of CO₂ in an absorbent solution following by regeneration of the absorbent solution. Aqueous solutions of amines are well known to be efficient chemical solvents for the CO₂ capture. A first pilot plant has already been started in Denmark (CASTOR project) using aqueous solutions of monoethanolamine. The future capture units will be integrated into industrial sites where fossil energy is used, such as power stations, metallurgy or cement factories. The pilot is efficient for a technological point of view but the integration is reported for economical reasons. Research works are actually carried out on new solvents or amines that will reduce the cost of CO₂ treatment.

The development of thermodynamic models representative of gas-absorbent systems is essential to study the vapor-liquid equilibria and dissolution properties. All these information are required to design and optimize the future capture units. For theoretical approach, reliable experimental thermodynamic data, such as gas excess properties of absorbent solutions, solubility and enthalpy of dissolution of CO₂ in aqueous amine solutions, are needed.

This presentation will focus on the adjustment of interaction parameters representative of none ideality in the gas-absorbent system and the methodology adopted to collect experimental.

Key-words : CO₂ capture; thermodynamic properties; modelisation

S1-25 Variability of the vulnerability to xylem cavitation in European beech provenances.

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Climatic models predict an increase of drought period such those of 1976 and 2003 in the next decades. For trees, xylem embolism has been shown to be implicated in diebacks caused by extreme drought (Brodribb and Cochard 2009). Our study model is *Fagus sylvatica* and our works aim to investigate the genetic variability and the phenotypic plasticity of the vulnerability to cavitation at the intra-specific scale. The vulnerability to xylem cavitation is quantified through the P₅₀ value, i.e. the xylem pressure inducing 50 % loss of conductivity, determined from vulnerability curves (Pammenter and Willigen 1998). Recently, we developed a new centrifuge technique (the "cavitron") for generating xylem cavitation and vulnerability curves (Cochard 2002; Cochard et al. 2005). Here, we present the results of the investigation performed on three beech ex-situ planting. One in Lyons-la-forêt (France) and an other in Burgette (Spain) and the last in Vrchedobroc (Slovakia). The variability of the vulnerability to cavitation was greater inside the provenance than between the provenance with P₅₀ difference up to 0.76 MPa, and the extent of this variability depends on the provenance considered. Concerning the phenotypic plasticity we found a significant plantation effect and a significant provenance x site interaction

Key-words : European beech, xylem cavitation

S1-26 Impacts of future climate scenario and summer extreme events on perennial grassland.

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At the end of the century, climate scenarios indicate increases of air temperature and atmospheric CO₂ concentration as well as a decrease of summer precipitations (IPCC, 2007). These mean changes will probably be associated with the occurrence of extreme event such as 2003 heat wave. Permanent grasslands supply forage for ruminants in quantity and quality, support high level of biodiversity and store high quantity of soil C. In this context we study how these main services are modified and how this grassland ecosystem is resilient. We manipulated in field conditions (Massif-central, France) the microclimate of permanent grassland with curtains to increase night-time air temperature and decrease precipitations (Beier et al 2004) to mimic four regionalised climatic scenario (Control without extreme; Control with extreme; 2050 without extreme; 2050 with extreme). Impacts of these treatments are first characterised by physiological parameters such as stomatal conductance and leaf water potential. Resilience of plant community is then studied by impacts on species diversity, and above-ground productivity.

Key-words : extreme events, resilience, air and soil temperature, soil drought

S1-27 Improving carbon dioxide capture through the use of fluorinated ionic liquids

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Preserving the planet and the ecosystem from climate changes, due to human activities, is one of the major research projects in academic and industrial research communities. Since 1970, increased anthropogenic GHG emissions, in particular those of carbon dioxide which is considered one of the principal GHG, contributed on global warming due to the emissions of infrared radiations in the atmosphere¹. Consequently, GHG emissions must be mitigated and actually, one of the most potential scenarios using advanced technologies is the 'Carbon dioxide Capture and Sequestration or CCS'. According to this scenario, carbon dioxide is captured by an absorbent from large scale fixed sources, i.e. fossil fuel power plants. Then, carbon dioxide is recuperated, compressed, transported and finally stored in deep geological formations.

Our work is focused on using a liquid based process for separating and capturing carbon dioxide from industrial effluents. It consists of studying experimentally the influence of addition of fluorinated functional groups in ionic liquids, a new class of solvents, with the aim to improve physical absorption of carbon dioxide. Imidazolium based ionic liquids with cation fluorinated alkyl chains and associated with both bis(perfluoroalkylsulfonyl)amide and alkylsulfonate anions increased solubility of carbon dioxide. From molecular point of interest, interpretation of the data was performed using simulation tools, where the preferential carbon dioxide solvation sites were identified and a mechanism of solvation for carbon dioxide could be proposed^{2, 3}.

1. GIEC, *Bilan 2007 des changements climatiques : Rapport de synthèse*, 2007.
2. D. Almantariotis, T. Gefflaut, A. A. H. Padua, J. Y. Coxam and M. F. C. Gomes, *J. Phys. Chem. B*, 2010, **114**, 3608-3617.
3. K. Shimizu, D. Almantariotis, M. F. Costa Gomes, A. A. H. Padua and J. N. Canongia Lopes, *J. Phys. Chem. B*, 2010, **114**, 3592-3600.

S1-28 Drying without dying: do potted saplings of *Fagus sylvatica* design more resistant branches in response to gradual soil drought?

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The climate projections for Central Europe predict an increase in the frequency and duration of intense summer droughts. Tree seedlings should make hydraulic adjustments to minimize the physiological impact of

xylem embolism. We hypothesize that the ability of beech saplings to withstand extreme soil drought is a key determinant of their survivorship. Thus, we carried out a census report on the sapling survivorship and a survey of soil moisture of potted seedlings grown under glasshouse conditions and assigned to a water shortage program in 2008 growing season. We determined the water potential inducing 50% loss of conductivity for 2009 year grown shoots of the alive saplings. The relevant results were i) a high correlation between the rate of sapling mortality and the level of embolism they experienced ii) the current year (2009) branches produced by saplings grown under drastic drought conditions in 2008 were as resistant to cavitation as the control ones. While, saplings grown under severe but not drastic drought conditions developed the most drought resistant branches to cavitation events. These results showed that xylem resistance to embolism is critical for tree survivorship in extreme drought condition.

Key-words: Drought resistance, beech saplings, vulnerability to embolism

Session 2: Cross-disciplinary approach: cross-tabulating biomes (crops, forests, grassland, aquatic environments, etc.) against farming sectors and geographic zones

Invited papers:

Adaptation of freshwater ecosystems to Climatic Change among which fish resources.

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INRA

Freshwater ecosystems are important reservoirs of biodiversity very sensitive to Global Change of which Climate Change is one part. These ecosystems are subjected to various pressures for a long time. It is absolutely necessary to reduce the demand on these ecosystems as resources reservoirs or waste receptacles. The Water Framework Directive adds further to several previous international agreements (RAMSAR, CITES, Habitat Directive...). The goals of these different conventions contribute widely to adaptation of freshwater ecosystems to Climate Change.

The most of following aims of the Water Framework Directive will probably facilitate adaptation of freshwater ecosystems to Climate Change:

- * expanding the scope of water protection to all waters, surface waters and groundwater,
- * achieving "good status" for all waters by a set deadline (2015),
- * water management based on river basins,
- * "combined approach" of emission limit values and quality standards,
- * getting the prices right,
- * getting the citizen involved more closely,
- * streamlining legislation.

For freshwater ecosystems, changes in water temperature, species distributions and habitat quality are the main impacts expected to result from climate change. It is important to recognize that the effects of non-climatic ecosystem stresses will continue to impact ecosystems, making it important to understand how climate change will interact with these stressors.

The increase of the temperature of freshwaters was almost 1.5 °C during the last three decades. In large rivers (Rhône, Seine), the repartition of species which prefer warm water is shifting upstream. The propagation to the upper part of the river is possible if there is no obstacle to the movement of fish. One condition for the good status of waterbodies in the Water Framework Directive is "The continuity of the river is not disturbed by anthropogenic activities and allows undisturbed migration of aquatic organisms and sediment transport". This condition is favourable to the adjustment of the communities to warming of waters. But the river continuity should not be always beneficial if we consider cold water communities or species which are protected as natural heritage or resources. Fish are commonly divided in three guilds (cold, cool and warm water), based on the optimal thermal habitats around which their thermal niche is centered. Salmonids are cold fish with a high value for sport fishing. The continuity of the river should be negative for species as brown trout or grayling. It is all the more negative because some lethal parasite should be transfer upstream if the continuity is good: the Proliferation Kidney Disease, lethal for brown trout and other salmonids, develops when the temperature is above a threshold around 10°C. Then the river continuity is a good recommendation of the Water Framework Directive but in some cases insulation of upstream water should be appropriate to protect some cold species.

The connection between river basins is another type of continuity to take into account. This will make easier the migration of species. Presently, a lot of species migrate in the canals between large river basin as Danube, Rhine, Seine, Rhône. As most of these species originate from warmer waters of the Ponto-Caspian region, their competitive advantage over the native species should increase, as waters warm in response to climate change.

The adaptation of species by genetic changes is not conceivable due to the speed of the expected change. But the natural biodiversity should be one way to use for this adaptation. The geographical distribution of most of the European species is very large. The populations living at the southern limit of their geographical distribution are living in warmer conditions than in the northern part. The canal connections between river basins allowing these populations to migrate to the North are probably not sufficient. Today the question of the use of southern populations to stock northern river basin is not solved. The question is shared by agriculture and forestry.

Warming will add to the risk of algal blooms which are caused mostly by eutrophication of waters. The algal blooms should produce phycotoxins. If the water is used for human activities, the treatment will need some new devices and the cost of use will be increased. If the waterbodies are or become in the conditions according to the good status of waterbodies recommended by the Water Framework Directive this risk will be reduced. This is true particularly in deep lakes where consequences of eutrophication will be intensified by warming.

All the stressors contribute to reduce the fitness of organisms. The limitation of pollutants in waterbodies is obviously favourable to the adaptation of communities to climatic change.

We can conclude that most of the adaptation options available to freshwater ecosystems are modeled on actions that were taken in response to non-climate stresses in the past. The Water Framework Directive is the best adaptation option for the next decade.

Oral communications:

Genetic structure and diversity of bacterial communities as affected by spatio-temporal variations of drought stress conditions in sahelian region

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The drought, which struck sahelian regions of West Africa during the 1970s-1980s, was one of the most significant climatic events of the 20th century. In the last two decades, the continuing below-average rainfall and human pressure has led to soil desertification. The aim of this work was to compare the genetic structure and diversity of bacterial communities in relation with the soil physico-chemical properties across four rainfall areas and the two seasons (dry and wet) in Senegal. Samplings of bulk soils were performed during the dry season and of bulk and rhizospheric (*Vigna unguiculata* subsp. *Unguiculata* L. Walp) soils during the wet season in 2009. Bacterial community structures and diversity were analyzed using Ribosomal Intergenic Spacer Analysis and 16S rRNA microarrays from DNA directly extracted from soil samples. The physico-chemical parameters were characterized. Between Group Analysis on data from bacterial community analyses and physico-chemical analyses stressed differences according to the spatio-temporal scales. The northern site, receiving the lowest rainfall, significantly differed from the other three sites from a spatial point of view. Following the temporal scale, the rainfall drove bacterial community diversity in all sites, except for the northern. In this site, the rhizosphere effect was stronger than the rainfall effect. Our results highlight the impact of climate change on soil and could lead to the identification of indicators of soil vulnerability.

Key-words : Sahel, drought, genetic structure and diversity, bacteria

From forest trees and stand vulnerability to extreme events to adaptive management: lessons from DRYADE national program

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Dryade project gathers an interdisciplinary consortium of researchers (ecophysiology, ecology, genetic, modeller, remote sensing), people in charge of forest survey (inventory, health status), and managers from both private and state forests. Recent climatic and biotic events induced forest decline in France. Tree and stand responses were quantified through crown condition and tree health monitoring (forest department network, national forest inventory), radial growth (dendroecology) for five major productive species of the French forest. Special attention was paid to interactions between drought and vulnerability to pests (bark beetle, caterpillars) and disease (root and leaf fungi). The objectives were (1) to quantify the impacts of

drought, pests and diseases on growth and health status in case studies, (2) identify edaphic, biotic, management and physiological vulnerability factors to decline, (3) to build models of vulnerability to growth loss or dieback for each species, (4) map vulnerability factors at national scale to assess the more vulnerable areas within the actual distribution of each species (4) to give recommendations to foresters to adapt forests and management to drought risk increase, either by reducing vulnerability (species or provenances, physiological status) or reducing the intensity of drought (improving water balance by water saving forestry) and biotic hazards (pest and disease control). Abnormal mortality occurs as a combination of extreme climatic and biotic events, misadaptation and mismanagement. A guide for silviculture during forest decline period was proposed as a tool for developing crisis management

Key-words : extreme event, vulnerability, forest decline, adaptative management

DRYADE (ANR-06-VULN-004)

Framework and first results of a regional analysis of yield stagnation based on trial and weather data

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Stagnating yields of key food crops in very different regions of the world has become an increasing preoccupation for food security. There is increasing evidence that part of this leveling off may be due to climate change, as evidenced by a recent study for wheat yields in France. The work presented here builds on this work, downscaling it at a regional level. The objective is to diagnose causes, evaluate consequences and propose potential solutions to wheat yield stagnation in the Champagne region, a key wheat growing area in France. The work is based on different sets of data: first of all, on over 10000 individual yield results from a network of variety trials since before 1980. Secondly, weather data from 15 local weather stations is available. Finally, the percentage of varieties actually sown in the region is used. The general framework for the study is presented here. It includes fitting of a linear mixed model to trial data to evaluate genetic progress and year effects, and validating it for extrapolating regional yield. It also includes computation and analysis of climatic indicators of key growth stages. Through this, the importance and difficulty of reaping full benefit from genetic progress is highlighted, and prospective solutions are discussed.

Key-words : Wheat, yield stagnation, climate, variety trials

Forecasting exercise on the adaptative ways of some livestock farming systems, using crop model outputs

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The ACTA Climate Change (CC) project joined research and technical institute forces to evaluate the risks of climate change for agriculture, to present the questions to agricultural leaders and to support thoughts on possible agricultural adaptations and on emerging questions to research. The project contained an exploration of still discernable changes in climate and crop behaviour, the description of characteristics of forecasted climates, an estimation of the effects of climate change on crop yields and schedules of several crops and the mobilisation of expert thought in order to put forward crop and animal solutions. The results of crop model simulations for 3 forage crops and the analysis of the possible changes of use in several livestock farming systems show that the impacts may be noticeably different between regions and between near and distant future. Alfalfa seems to be a crop of the future, because the production seems not to be decreased even in the distant future, with higher temperatures and higher lack of water, unlike the grasses. Maize used as silage seems to have a good behaviour. For grasses, an important result is the change of seasonal evolution of the production (more in spring and winter, less in summer), leading to new feeding managements. In some regions, it will become possible to graze in winter, while the portability of the soils (spring rain) will keep it in some others, even in spring. Our talk aims to analyze these changes and adaptations in several regions for some livestock feeding and farming systems

Key-words : Systèmes d'Élevage , Prospective, cultures fourragères, prairies

Change in recharge of aquifers under several cropping systems due to climate change. Consequences on land use at territorial level

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Climate change will produce a decrease in rainfall over French territory, especially in western France. Cropping systems pattern is a key factor in water resources management at catchment basin level. In the frame of the ANR French project "Climator", we have undertaken an analysis of the relationship between rainfall and the annual supply of water to the aquifers under several cropping systems and ecosystems. This was performed through crop modelling using agroclimatic data provided either by measurements at 12 experimental sites in France (1971-2000) or by using regionalised outputs of the French climatological model Arpege (2021-2050 and 2071-2100). The simulations highlight the important differences in aquifers recharge between cropping systems (rainfed vs irrigated but also winter vs spring crops and annual crops vs perennial vegetation). For the 12 sites, they also give an estimate of the decrease with time of the annual recharge under each cropping system (at least 2/3 of rain decrease). In the driest locations, that decrease may lead to a partial change in cropping systems pattern in order to match the total water demand at catchment level. Such change could be devoted either to increase annual recharge when irrigation water is pumped from large aquifers or to reduce summer water demand when irrigation water comes from rivers. Both cases are illustrated.

Key-words: Climate change, cropping systems pattern, recharge of aquifers, irrigation.

Posters

S2-1 Using simple phenoclimatic indicators to evaluate adaptation strategies to heat stress during wheat grain filling

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High temperatures are known to negatively affect grain filling of wheat leading to lower yields. Projected climate change, through increased spring and summer temperatures, will probably lead to more frequent and intense yield losses due to excessive temperatures. Recent studies at the French level show that this evolution has already started. The purpose of the work presented here is to quantitatively evaluate and compare different adaptation strategies to heat stress during grain filling, namely escape -through sowing dates or phenology - and tolerance. 4 climate series obtained from the Climator project were used across 12 sites. A phenological model was used to estimate median heading dates for 3 periods (1970-2000, 2020-2050, 2070-2100). This information was coupled with the calculation of median number of days with excessive temperatures during grain filling for a wide range of heading dates. This allowed for an objective quantification of the evolution of heat stress risk. Different adaptation strategies for the future (modified crop phenology, earlier sowing dates, tolerance to heat stress) were tested using this framework. Results show that tolerance to heat stress will probably be a much more efficient tool than escape. It is also shown that although escape may not permit significant reductions in risk, improper wheat phenology can lead to significant increases in heat stress risk. The results presented give insight for prioritizing actions in breeding and research.

Key-words: heat stress, wheat, grain filling, climate change adaptation

S2-2 Ecological and genetic studies on phenology in temperate fruit tree species to adapt the flowering phase facing temperature change

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Facing climate change, fruit tree cultures show many barriers and vulnerabilities to climate adaptation as perennial and complex cropping systems, considerable irrigation needs, multiple parasitism and strong regional links. Since the beginning of the 2000s, climate impacts on tree physiology are beginning to be visible and are liable to production irregularities in southern Europe particularly. Thus, considering also the current economic trouble of the fruit industry, evident needs of climate adaptation led to develop increasing researches on

impact detection for main traits, particularly for floral phenology, and on ecological and genetic determinisms of emergent impacts. Regarding floral phenology, various approaches and tools have been used, as field observations, dormancy experiments, modelling and genetic mapping. Some significant results are presented for the ecological approach of floral phenology, which is an essential step to determine adaptation objectives. They deal with changes in flowering time in Europe and with their subjacent determinisms in terms of changes in dormancy breaking (chilling effect) and in floral growth for blooming (heat effect). Preliminary results on genetic determinisms of flowering time are also presented (QTLs mapping) as essential step to have efficient tools for breeding works aiming at phenology adaptation. The main challenge will be more integration between such results in order to reduce effectively main risks and catch benefits. This would lead to adapt fruit tree cultures at the regional level (culture system, varietal panel) considering also the European level for research collaborations and economic complementarities.

Key-words : adaptation, dormancy, blooming, genetic mapping

S2-3 Effect of climate change on growth criteria and yield of root crops in Iran

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Yield and growth criteria of sugar beet and potato were studied under simulated climate change. Monthly variation of mean for temperature and rainfall under doubling CO₂ concentration for Tabriz in Iran was evaluated by using two General Circulation Models (GCM). The coefficients were applied to the long term climatic data of Tabriz and the effects of these changes on growth, maturity duration and water requirements of sugar beet and potato were simulated by a crop simulation model (OSBOL). Based on the prediction made by GISS and GFDL, mean annual temperature were increased by 4.6 and 4.3 °C, respectively. These values were 32% and 1% increase for rainfall. Doubling CO₂ concentration reduced number of days from planting to maturity and increased biological yield, root yield and water requirement of sugar beet, but number of days to maturity and water requirement were reduced for potato

Key-words : Climate change, Crop productivity, Dry matter, Environment

S2-4 Evolution du climat et viticulture - Analyse de la perception des professionnels et des experts

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A questionnaire based on a review of relevant literature has been drawn up and posted online <http://www.vignevin.com/enquete/index.php?sid=25218> to establish an overview of climate change and its repercussions on the wine-growing industry.

The aim of the first section is to take an inventory of the various manifestations of climate change on vineyards, based on observations from wine-growing professionals.

Lastly, the questionnaire concerns the repercussions in relation to vineyard management and the measures envisaged to limit the causes of climate change.

The aim of the communication is to present a summary of the problem of "climate change" and itemise the answers to the questionnaire and the aspects developed during the individual interviews with professionals and experts.

French wine-growers have observed that harvesting dates have been moved forward by 8 to 12 days.

The questionnaire highlights a significant rise in droughts, an increase in potential alcohol musts of 0.5 to 1 °C and a drop in acidity (in H₂SO₄) of approximately 0.5 grams per litre have been noted.

As for areas of research, the aspects considered the most important by wine-growing professionals are, respectively, temperature control of grapes, musts and wines, soil management, dealcoholisation and programming irrigation.

Key-words: Changement climatique, viticulture

S2-5 Introduction of the culture of *Jatropha curcas* associated to niébé on the marginal grounds of northern Cameroon.

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This paper presents the influence of the agricultural fertilizers and the techniques of the growing of *Jatropha curcas* associated to *Vigna unguiculata* var *lori* on the degraded marginal grounds. The study was conducted from 2009 to 2010 with overall objective to solve the problem of the reduction of the fertility of the grounds and to reduce the increase in the price of the fuels in the northern Cameroon. The main objective was to study the influence of the various amounts of NPK and the cow's dung, the growing's techniques and the types of degraded grounds on the parameters of growth and development of *Jatropha curcas* associated to niébé (*Vigna unguiculata*). The experimental device used is a block completely randomized with five levels of fertilization (F0: witness parcel; F1: 50 g, F2:100 g of NPK 15-20-15; F3: 1 kg and 2 kg of the cow's dung) and two types of growing (germinator: Ge, direct sowing: Se) with three repetition. The results showed that the rate of germination of the germinator is 95 % and that of the direct sowing is 40 %. The rate of survival of the germinator is between 75 and 95 % and that of the direct sowing from 50 to 82 %. 100g of NPK and 2kg of cow's dung strongly induce the growth of *Jatropha curcas* and niébé. So it can be seen that *Jatropha curcas* adapts on the marginal ground. From this study, it could be recommended that the germinator and the amounts of 100g of NPK and 2 kg of cow's dung are to be popularized.

Key words: Jatropha curcas, fertility, marginal grounds, northern Cameroon

Session 3: System-scale approach: socioeconomic, environmental and territorial consequences of climate change adaptation;

Invited papers:

Some economics of adaptation to climate change, and implications for public policies

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As adaptation quickly evolves from a relatively esoteric to a very concrete topic, from pressure building for action, notably at the local level, and with important policy decisions and plans in the making, this talk aims at providing some insights on the design of adaptation policies, from an economist' perspective. This talk draws in particular on a report prepared for the Ministry of the Environment,⁵ and it aims at making three main points.

1. Adaptation is not always at the margin

Adaptation to climate change is not an easy endeavor. First, the term adaptation encompasses a very broad and diverse set of actions in most sectors and most regions. Second, adaptation decisions must be made in, as described by Lester Lave, "a sea of uncertainty". Yet past experience suggests that it would be too expensive to rely solely on "reactive" (or ex post) adaptation decisions (e.g., evacuating cities threatened with hurricanes, rebuilding, etc.); and that some "anticipative" (ex ante) action is warranted. This is all the more difficult in the sectors where there is important inertia -- for example in the forestry or in the infrastructure sectors -- and thus where adaptation considerations have to be made far in advance.

The points mentioned above illustrate the fact the similarities between adaptation and mitigation decisions (which must also be taken in a context of important uncertainty, inertia, and growing information). In fact, the parallel is worth pursuing further on. This is because, just as mitigation may require large-scale bifurcations in the energy sector, adaptation may often require not just actions "at the margin", but large-scale changes in activities and locations. Though the link between climate change and frequency of hurricanes in the Atlantic remains controversial, the current discussions about the future of forestry in the region Aquitaine -- with all the implications for land-use and industrial development -- provide a good illustration. Despite the fragmentation of adaptation decisions at a sectoral / regional level, coordination across sectors at the level of an entire territory is thus very important.⁶

2. Introducing adaptation in public policies is often, but not always, justified from an economic standpoint

From the point of view of an economist, mitigating climate change provides a clear public good (the "quality" of the climate). As a result, there are strong reasons to believe that private agents will not spontaneously produce the socially optimal amount of that good, and thus some form of public intervention is warranted.

The case for public policies on adaptation, on the other hand, is less clear-cut. In fact, adaptation often provides a private good, in that the benefits of adaptation actions can be captured by the agent who has paid for them. For example, a homeowner who adds an air conditioning unit to his apartment will benefit from a more pleasant environment when the next heat wave occurs. In such cases, private agents have a direct incentives to adapt, without public intervention.

The above story, however, is not general. There are several cases in which "spontaneous" adaptation may either not occur, or not occur in the direction, or at a level, that is socially optimal. Reasons include, inter alia,

- lack of information by private agents: e.g., one cannot adapt if he is not aware of the risks associated with climate change,
- barriers to collective action: e.g., it might be much more efficient to adopt collective water management strategies rather than individual well drilling, and public intervention may help in reaching such agreement,
- externalities associated with "bad" adaptation decisions by private agents: e.g., the public costs (health care, etc.) associated with individuals locating themselves in 'at risk' areas.

⁵ Hallegatte, Stéphane, Franck Lecocq and Christian de Perthuis. 2010. Economie de l'adaptation au changement climatique. Rapport pour le Conseil Economique pour le Développement Durable, MEEDDM. <http://www.developpement-durable.gouv.fr/IMG/pdf/001-3.pdf> .

⁶ All the more so that lack of a common metrics between adaptation measures makes it much more difficult to set up instruments that provide a link between sectors--such as carbon markets do in the mitigation world.

- poverty and distributional constraints: e.g., Society might want to help those who are adversely impacted by climate change.

The role for public action on adaptation must thus be examined on a case-by-case basis.

3. Introducing adaptation into policies is much more than "brick-and-mortar"

The type of public policies that are warranted are not just "brick and mortar". Adaptation is sometimes confused with "hardening" of bridges, roads, or buildings, and more generally with building dedicated infrastructure such as dikes. Though those clearly constitute adaptation options, the portfolio of adaptation policies is much broader.

First, information is a central element in adaptation policies, in a context of important uncertainties about the impacts of climate change, and thus about the benefits of adaptation measures. This includes production of information (i.e., R&D), but also dissemination of information, and detection of early signals of climate change (e.g., forest and ecosystem health surveillance networks, etc.).

Second, adjusting norms and standards is critical. In many sectors, norms and standards are key the way by which the Government passes on information to individual decision-makers, notably on the acceptable level of risks (e.g., a bridge must be designed to withstand a decadal or a centennial flood). Yet these norms are typically computed based on past data, and thus not necessarily adapted to the future climate. Guidelines (i.e., norms that are not compulsory, but provide reference to individual decision-makers), must also be adapted.

Third, institutions will have to be adapted. For example, water management arrangements that are designed in a situation of relative water abundance may not be suited for situations of increased scarcity. Given the uncertainty associated with climate change, and given the dynamic nature of the phenomenon, finding flexible arrangements is necessary. And as noted in the beginning, coordination within sectors to manage bifurcations will become essential.

Oral communications:

Characterization of climate change and its consequences on agronomic potentialities in a pastoral region -

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Climate change is a global phenomenon whose consequences differ locally. To evaluate its local consequences on agronomic potentialities, one has to define a reference area, here piedmont and mountains of the French Pyrenees. On this area, to characterize climate changes, 30-years-long simulated climatic data around 2050 have been compared to observed data of the past 30 years. Agroclimatic indicators e.g. the duration of summer water stress, have been derived from this data. Changes in the duration of grass growth stages (e.g. early vegetative, reproductive, dormant) as well as in the constraints to grassland use (e.g. plot carrying capacity) can be inferred from such indicators. The Herb'Sim model simulating grass growth and nutritive value for different types of grassland communities then provides estimates of grass availability for mowing and grazing. Simulation results show for instance that, in the reference area and under the A1B IPCC scenario, warming is concentrated on summer. Water stress is longer and higher due to a decrease in yearly rainfall amount rather than to the increase of evapotranspiration. As altitude gets higher, warming is less intense. Indeed, even if yearly rainfall amount decreases, it remains sufficiently high to avoid water stress. Climate change generally modifies the timing and duration of grass production and usability over the year. This calls for designing novel livestock systems adapted to 2050's climatic context (see related paper by Martin et al.)

Key-words : climate change, Pyrenees, agroclimatic indicators, livestock systems

Are South Indian farmers adaptable to global change? A case in an Andhra Pradesh watershed -

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Global changes are already impacting South Indian farmers. Climate change is affecting the agricultural sector as it relies on climate and water resources availability. Impacts are likely to be stronger in semi-arid hard rocks areas as they are poorly endowed with water resources. As a matter of facts, this area is additionally

experiencing a deep agrarian crisis, which is linked, among others, to debt and credit problems. Current farmers' vulnerability (a function of sensitivity and adaptive capacity) to these changes has been assessed in a watershed of 80 km². The objective of the paper is (1) to present the method used to describe and assess farmers' adaptive capacity within the vulnerability index, and (2) to discuss farmers' ability to adapt to stressors. Farmers' adaptive capacity indicator is composite and based on livelihood assets approach. Composite indicators are weighted by experts using an Analytic Hierarchic Process and valued through individual surveys. A normalized score is calculated allowing ranking farmers according to their ability to adapt. Scores are compared and analysed. Results show disparities among the villages with higher adaptable rates in "urban" ones. Marginal and small farmers appear to be less adaptable. AHP method allows explaining the reasons of disparities between farmers. As a conclusion, adaptation variability seems more important between than within villages. The AHP method is interesting to identify where policy makers could focus to improve farmers' individual adaptive capacity.

Key-words : Adaptive capacity, Agriculture, Global change, Multicriteria decision analysis

Lake Chad shoreline fluctuations and their consequences for local population livelihood.

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The sahelian farmers are facing very rapid disruptions of their environment, partly of climatic origin. They can locally affect the survival of populations but also create opportunities for innovations which involve also elements of risk for sustainability of ecological and social systems. The weakness of the States largely leaves farmers to find innovative solutions and then to cope with the unintended effects. The Lake Chad is an example of extreme sensitivity of natural and social systems to climate change. Its surface decreased from nearly 20 000 km² during the 50's to less than 2 000 km² due to the droughts since the 70's, and its northern part has been dried repetitively. The hydrology of the Lake and its climatic control have been studied and are currently modelled. Here we focus on the human aspects this Lake Chad climate system in its Nigerian Northern part. Rainfall agriculture and fisheries which formerly based livelihood strategies are relict except for scarce good rainy years. Two major innovations have been implemented: adoption of a new crop produced in irrigated modern and intensive agriculture system and known as the local product Diffa pepper; flood retreat farming without irrigation or fertilizers on silt type rich soils made available due to Lake retreating. This system, his dependence of water availability and soil properties will be presented from the three points of view of hydrology, anthropology, and soils sciences, aiming to inform policymakers of adaptation strategies to climate changes in this remote area of Niger

Key-words: climate changes, Lake Chad, Diffa Pepper, retreat flood farming.

Horticultural production systems and land and water resources in the Venezuelan Andes : a tenable combination ?

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The communication submitted analyses the opportunities and limitations caused by climate change on horticultural systems developed since the 1970 in the Venezuelan Andes. Responding to a new food scheme, the production of temperate vegetables can be achieved only in the highlands of the Paramo for agroecological reasons (various tubers, carrots, garlic). The reduction of frosts, in particular¹, observed since several years, has an important repercussion on methods of soil occupation of these highlands. As it has been turned to account by farmers, it has permitted a distinct altitudinal raising of agricultural limits, thus modifying distribution areas of several cultures. However, these production systems meet certain limits, both agroecological as environmental as they are based on extensive use of irrigation, depending on water resources of the Paramo² and the clearing of vulnerable soils, that are inhabited by fragile ecosystems, (among others presence of fralejon *Espeletia schultzii*).

In this context, we propose to analyze the extension of these farming systems and their environmental impacts in particular on water and soil availability and the adaptations made by producers to limit the pressure on natural resources (in while concurrently recalling parallel the major climate change observed). Furthermore, we will characterize a diachronic approach, representations conveyed by the actors and the socio-economic stakes, highlighting the development evolution, of the productions, the areas concerned affected surfaces and the practices associated with production systems in selected irrigation perimeters. We thus present the case of two municipalities of the Merida state, Venezuela (municipalities of Rangel and Miranda).³

¹ In fact, modifications of the pluviometric regime have also been observed, and have influences upon agricultural practices.

² Essentially sources and streams, but also inherited lagoons. The water is mobilized as part of collective irrigation schemes generally take water from some distance in the paramo.

³ This work is developed under a project PICS, Programme International de Coopération Scientifique, financed by the CNRS titled : mutations in tropical mountains and environment. Vulnerability linked to water in the Venezuelan Andes, in collaboration with the research laboratory GEODE-UMR 5602 CNRS, Toulouse, France.

Key-words : market gardening, agrodiversity, water, Andes

Impact du climat sur les rendements et les revenus : un essai d'évaluation à l'échelle européenne -

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We focus on impacts of climate change regarding crop yields, land use and agricultural gross margins across the European Union. Preliminary results are provided by an integrated modelling approach combining a crop model (STICS) and an economic model (AROPAj) of the European agricultural supply. The modelling framework is designed to perform quantitative analysis, regarding climate change impacts on agriculture and more generally the interactions between soils, land use, agriculture and climate integrating physical and economical elements (data, process, models). It explicitly integrates an agricultural diversity dimension with regards to economic set of choices and soil climate spatial variability.

First results are given in term of quantitative analysis combining optimal land allocation (economic optimality) and "dose-response" functions related to a large set of crops in Europe, at the farm group level, covering part of the European Union (EU15). They indicate that accounting for economical and spatial variability may impact both regional aggregated scales results

Key-words : climatic change, economic model, crop model

Economics of Tree-Species Conversion under Climate Change Risk -

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Since typical rotation lengths of major commercial tree species range between 4 and 15+ decades, forest managers must already factor future climate change risks in their current plantation / natural generation decisions—despite the large uncertainties that still characterize the impacts of climate change on forest ecosystem dynamics. In practice, some managers have already decided to shift to climatically more robust and/or to shorter rotation species. Yet such transitions have been mostly studied from the ecological side. So this paper provides economic insights of timber species change as a tool to adapt forests to climate change, taking uncertainty into account. To do so, we use the framework of cost-benefit analysis, taking uncertainty into account both exogenously via sensitivity analysis, and endogenously, via (quasi-)option value calculation. The analysis is illustrated with two types of conversion: from Norway Spruce to Douglas Fir and from European Beech to Sessile Oak or Black Locust (transition option). Conditions under which species shifts make sense and optimal timing of species shifts are exhibited. We calculate the value of additional information (research), and show that it should not be neglected. Cost-effectiveness of transition options with shorter rotation species appear especially sensitive to initial costs. We show that despite uncertainties, cost-benefit analysis provides significant insights on forest adaptation to climate change.

Key-words : Quasi option value, adaptation, forestry, species choices

Posters

S3-1 Les changements climatiques et l'agriculture de conservation DANS LES milieux semi-arides

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In the context of the climate changes, the cereals' culture appears relatively vulnerable because of some of his characteristics, as well physiological as socio-economic. Uncertain rain agriculture in the semi-arid and arid areas and their need hydrous annual negatively affects the production and the output in grains. The study of the ground various parameters (the ground humidity) was conducted. And farming parameters output such as the rate of survey, the adventitious infestation and the corn grains yield and these components. The

experimental device including the technical factor farming on three levels: zero tillage, conventional tillage and simplified cultural technique (SCT) and only one cereal species. Positive hydrous assessment in zero tillage and also yield components and the grain yield was shown. The zero tillage, in addition to its advantages as regards evaporation reduction, makes it possible to fix well the cereal cycle. It also makes it possible the culture to benefit from the first year rains and to escape the dryness's from end from cycle.

Application finality: To moderate some causing effects climate warming.

Key-words : rechargements, semis direct, durabilité, conservation,

S3-2 Alpages Sentinelles : un espace de dialogue pour faire face aux changements climatiques

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Several droughts in a row since 2003 have risen questions about how these natural events may impact mountain pasture resource and management. Scientific experts, members of the "Zone Atelier Alpes" (CEMAGREF, LECA, LTHE), and mountain grassland managers (pasture managers (CERPAM and FAI), Agriculture Chambers, The Ecrins National Park) have decided to gather their knowledge and experience in an original and common observatory. Consequently, they've set up monitoring tools to survey agricultural practices, pasture resources, landscape and biodiversity in regards to climate changes. The collected data are as various as rain duration and period, snow cover, vegetation amount and diversity, shepherd habits, grazing pressure, etc. All of them form the basis of a shared diagnosis on evolutions of pasture practice, and its consequences on vegetation resource as well as biodiversity. The aim of this program is therefore to understand how a mountain pasture system (presently, in the territory of The Ecrins National Park) evolves facing global climate change, and how scientists and managers may follow and help inherent changes for breeders and shepherds. The program has started off in 2008. Two years of monitoring are a period too short to highlight results. However, first uses or questions about these tools can already be pointed out.

Key-words : Alpages, climat, partenariat, Ecrins

S3-3 Which farming systems to adapt to climate change? (1) Building of socioeconomic and agronomic scenarios and definition of farm types

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Around 2050, changes of climate and of the worldwide socioeconomic context will require agriculture to adapt. The extent of these adaptations remains uncertain so far. Designing livestock systems adapted to climate change requires a prospective study about their local socioeconomic context around 2050. To this end, we have developed a scenario building methodology. It is articulated around workshops based on active participation of stakeholders. It involves stages of scenario evaluation, formalization and deepening by researchers and field experts. Starting with livestock industry scenarios, animation techniques and artifacts (used in the ergonomics sense, e.g. dynamic conceptual schemes) have been used to define farm types considered realistic in this new context. This regards for instance surface areas and intensification levels compatible with viability and liveability of the farms. Scenarios have been developed for two case studies: beef and dairy bovine production systems in the piedmont and in the mountains of the Pyrenees. Discussions involving local stakeholders have led to consider two contrasted scenarios: one assuming economic liberalism with low considerations for environmental issues, and one assuming a relocalization of food production with demand from the society for environmental services. Four farm types have been identified for each scenario and each type of production (beef and dairy). According to these farm types, a second group of stakeholders is now designing the livestock systems adapted to 2050's context (see related paper by Martin et al.).

Key-words : climate change, scenarios, participatory research, livestock system

S3-4 Adaptation aux changements climatiques de l'agriculture et des écosystèmes : Cas de la culture des champignons comestibles dans les Régions du Centre, de l'Est et du Littoral camerounais.

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En collaboration avec : Délégations régionales du Ministère de l'Agriculture et du Développement rural du Centre, de l'Est et du Littoral, département des physiologie et biologie végétales de l'université de Yaoundé, projet champignon d'Obala, université de Dschang, agents de vulgarisation de zone.

Cameroon is located in central Africa .Like other countries in the world, we are victim of the consequences of climatic disturbances .The increase of ocean and atmosphere average temperatures through out the world for many years running has led to flooding, forest fire, drought, new insects invasion, different form of pollution with diseases as cholera, malaria, cataract, skin cancer, respiratory disease. This has also led to the reduction of agricultural yield due to the disappearance of many vegetable and animal species. Since the struggle against hunger and poverty is the major preoccupation for the government of my country, the preservation of biodiversity and the protection of nature are very important we need to take different measures to attenuate the consequences of these threats.

The purpose of this congress is to investigate the economics of climate change mitigation and adaptation options in developing-country agriculture, animal husbandry and forestry contribute significantly to global greenhouse gas emissions.

The Cameroon government in 2005 created the ministry of environment and the nature protection by breaking the former ministry of environment and forestry into ministry of forestry and wildlife in one case, and the ministry of environment and the nature protection in other, bring this out a particular importance of environmental problems and the absolute importance to protect and conserve our environment The strategies used to fulfil these are environmental education, information, training, and sensitization of population on natural resources conservation, supporting all initiatives in defence of soil restoration and reforestation and the struggle against bush fire

According to edible mushroom cultivation, we must identify and vulgarize different methods in adaptation to climate change in centre, east and littoral regions in Cameroon. Edible mushroom is cultivate in Cameroon since 1996, introduce in the country by Chinese cooperation. A sample of edible mushrooms farmer are identifying throughout these regions to check their method of struggle against inclemency. These are also done for the adaptation of few products that may contribute to maintain sustainable development and food security. The selection of different products, the selection of varieties, the struggle against insects and different post harvest management methods are very important. Economics of mitigation of climate change in tropical agriculture and forestry (financial and economic valuation of micro-level mitigation options, bio fuels, land use change, crop production and animal husbandry, payment for environmental services, policies regarding reforestation /avoidance of deforestation, etc.).

Key-words : genres pleurotes / volvaires ; Exploitations familiales agricoles ; Petits agriculteurs et moyen exploitants

S3-5 Issues in farming systems modelling for climate change investigation

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The pace and scale of change of livestock systems required by climate change raise many questions in need of further investigation. Simulation models can be valuable tools to evaluate agronomic, social and economic performances of livestock systems faced with climate change, and to support the design of systems adapted to these new conditions. We assume this requires that such models (i) are focused on the farm scale, (ii) integrate biophysical submodels (e.g. for grass growth, calf fattening) parameterized for climate change studies, (iii) consider grassland, animal, and farmland diversity, (iv) represent the structure and dynamic functioning of livestock systems, in particular how the farmer copes with unpredictable factors. For each of these aspects, this communication reviews the state-of-the-art in the field of agricultural modelling. It identifies current limits of available models (and submodels) and suggests modelling choices to address these limits in the context of climate change studies. To illustrate this purpose, we present our modelling choices made for extending the validity domain of the SEDIVER model from grassland-based beef systems to dairy systems including cropping. The genericity of such modelling choices and the remaining research challenges in the field of agricultural modelling are discussed.

Key-words : simulation, biophysical model, decision-making model

S3-6 Which farming systems to adapt to climate change? (2) Livestock systems design and evaluation

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Climate change will require changes in the structure, functioning and organization of livestock systems. To support such changes, agronomic research has to improve its understanding of how agricultural stakeholders would design, evaluate and adapt these novel systems. To this end, we have developed a methodology to support the design of livestock systems adapted to climate change. This methodology is participatory: knowledge is co-produced by researchers, agricultural advisors and farmers. It is integrative: it takes into account agronomic, economic and social consequences of changes in the livestock systems. It relies on the iteration of stages of (i) design of livestock systems adapted to climate change and to socioeconomic scenarios defined previously (see related paper by Felten et al.), (ii) evaluation of their biophysical and organizational feasibility. During these stages, it makes use of different simulation tools (e.g. prototyping mock-up, computerized farm model of beef and dairy bovine production systems). The first results of the methodology application to designing beef and dairy bovine systems for year 2050 in the French Pyrenees are presented. Their potentialities to formulate possible adaptations of livestock systems to climate change are discussed, as well as the genericity of the results and of the methodology employed.

Key-words : participatory research, modelling, simulation, farm management

S3-7 Impact des changements climatiques dans les exploitations agricoles familiales au Cameroun

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The climate is a very significant factor that determines the increase in agropastoral productivity. However, since the past few decades, most African countries, especially Cameroon have been facing varying climatic changes with devastating effects on agricultural exploitations. The high level concentration of green house gases in the atmosphere has led to global warming of the planet. The climatic change is causing food crisis due to the fragility of the ecosystem. About ¾ of the population depend on agropastoral production and most the families are carrying out small hold farmings. The frequent effects of these climatic changes has brought uncertainty into their activities and can cause an agricultural change in different ways ; failure of traditional and cultural farming methods, loss of cattles and fish, rarity of water and the destruction of other factors of production like agricultural lands, forests and reduction of water bodies for fish. If all productions are influenced by climatic changes, then, the impact will be unfavourable to the tropical region and Cameroon in particular. On the other hand, these negative impacts can be contained if sustainable management measures are adopted and strategies are adapted to reinforce prevention and resistance to risks.

The objective of this research is to demonstrate the impact of climatic changes on sustainable agricultural exploitations in Cameroon. That is, to show how climatic changes are manifesting on sustainable agricultural exploitations in Cameroon.

Key-words : Environnement, exploitations agricoles, familles, sécurité alimentaire

S3-8 Impacts et stratégies d'adaptation de la population locale au changement climatique ; Cas du bassin versant d'Oum Zessar Sud-est tunisien

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Tunisia ratified the International Conventions of the climate change and made significant efforts in the development of the national strategies of adaptation to this phenomenon. With a local scale, this communication (and poster) milked in a first part impact of the climatic change on production systems in Oum Zessar Watershed. The second part of this intervention relates to the analysis of the local population experiment in the development of their own strategies of adaptation to this phenomenon. The objective of this study consists in describing of climate change phenomenon impact on the production systems of the study area, and analyzing measurements of the local population adaptation on this phenomenon.

The methodological tools were based on a bibliographical review on the International Conventions of the Climate Change ratified by Tunisia, and on the national strategies of adaptation. For this, surveys with farmers and women as the discussions with the engineering departments were carried out. The results of this communication related to the impact of the climate change on the operation of production systems of the zone, as well as measurements on this phenomenon.

Key-words: Changement climatique, Impacts, Stratégies

S3-9 Mountain farming and climate change: local farming adaptation strategies for dairy farms in French Alps.

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The adaptation of mountain farming to climate change became a major question. Since the drought of 2003, the mountain farmers in French Alps face in the incidences of various climatic disturbances and try to adjust their practices "as things come" to maintain their production or their activity.

In order to propose local farming adaptation strategies, workshops of local experts were constituted to establish solutions face to two future climatic scenarios in Alps: a random climate scenario (S1) and a ten drought year's scenario (S2).

These "expert solutions" were then proposed to 50 dairy farms, differentiated by food cattle, practices intensification and mountain pasture management. Farmers could accept or reject it or suggest new solutions. The 2009 survey results show that the farming adaptation measures depend of "external factors", as land exposure to climate change and territorial resources available for farming (water and land) and "internal factors", as farm flexibility and farmers' acceptability.

Key-words : climate change; mountain farming, adaptation strategies, French Alps.

S3-10 Quantitative approach to assess farming system resilience to climate change uncertainty.

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Assessing the resilience of farming system to climate change through their cropping system diversity and socio-economic context is an important challenge for policy makers in the Mediterranean region. In fact, decision-makers are often confronted to contradictory demands when it comes to developing projects to foster suitable strategies of less resilient farms. This paper aims at developing and using a multi-scale quantitative approach for assessing, at short and long-term, the impacts of climate change on farm resilience behavior and various socio-economic and environmental indicators. Two scenarios, the business as usual and climate change, with a time horizon of 2030, have been developed and compared for representative farming system in northern Tunisia. The results of this study indicate that more than 70% are identified as resilient to climate change. Those farms are mostly cultivated with cereal and forage crops, less sensitive to water stress and soil salt accumulation. Inversely, 15% of farms which are dominated by orchards are usually less resilient. Those farms showed an important drop of their farm income (30217 DT), due mainly to their incapacity to adjust their cropping system under water stress condition and soil fertility degradation.

Key-words : Resilience, bio economic modeling, agro-environmental and economic indicators, risk.

S3-11 Fuel wood: a multi-scale approach for a local resource.

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Considering issues such as widening the range of available energies, reducing greenhouses gas and promoting sustainable development, fuelwood is a renewable energy presenting an important potential and not competing with food. In Auvergne especially, developing its use allows to promote a new territorial and local resource, according to the definition given by Pecqueur (2003).

BENEFITS is a PSDR project which has begun in 2009, focusing on the development of the fuelwood for the environment in territories. The main goal is to observe and assess changes ongoing, understand their dynamics and the territorial logics already existing or in process, and finally to think ahead future possibilities, by

making scenarios that the key actors could use to cooperate and participate. BENEFITS is a multidisciplinary approach mainly based on three components: geography, economy and ecology.

That is a reason to study how different governance scales are embedded and participate to the development of the fuelwood industry. Actually, when speaking of renewable energies, local scale is considered first. But defining what local scale is an tricky issue: each stakeholder tends to consider that its own work scale is the local one, or, for national stakeholders, that the French "region" is a local scale by itself. Hence some misunderstandings to be handled in a loco-regional governance.

Key-words : bois-énergie, ressource territoriale, Auvergne

S3-12 Predicting ozone deposition fluxes: the relative roles of deposition and detoxification processes.

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Tropospheric ozone (O₃) is a widespread and damaging air pollutant in industrialized countries; its concentration may episodically reach levels that can cause acute damage to vegetation. Cumulative exposure to ozone at chronically high levels may also reduce growth and productivity of agricultural crops. The objective of the present paper is to couple a soil-plant-atmosphere continuum model accounting for all the factors controlling stomatal conductance with an ozone deposition model. The ozone deposition model addresses the partitioning of the total ozone canopy flux into stomatal and non-stomatal fluxes. It accounts for diurnal variability of detoxification processes and reactive ozone uptake on cuticular waxes and soil surface. The mechanistic modelling of plant defense reactions is based on the Plösch et al. detoxification model (2000) in which the dynamics of apoplast chemistry are considered. To estimate ozone deposition fluxes on cuticular waxes and soil surface, we use a revised version of the Morrisson and Nazaroff (2002) model developed to account for ozone uptake on material surfaces. By linking the diurnal information associated with apoplastic ascorbate with the diurnal patterns of uptake and hourly O₃ concentrations, a better quantification of effective flux may be achievable and thus, a better estimate of plant response to O₃ attainable, resulting in more reliable inputs in the standard setting and critical levels processes.

Key-words : Mass-transfer model, ozone, detoxification, deposition.

Federation on Environnemental Research of Clermont Ferrand.

The aim of the approach initiated in 2008 is to federate research work carried out in the environmental field at Clermont-Ferrand, in particular by adopting a multi-disciplinary strategy that draws on the strengths of various scientific fields, ranging from the "hard" sciences to "soft" sciences.

The main scientific goal of the Federation is to forecast changes in the quality of the environment in a context of overall change, by assessing and quantifying the impact of human-induced activities on the atmospheric, aquatic and terrestrial systems in order to simulate future changes, anticipate risks and propose durable management and remediation actions.

More precisely our aim is to contribute to the following, using targeted research actions:

- **understanding** and quantification of the mechanisms and factors explaining changes in the quality of the environment in order to assess the impact of natural and anthropogenic disturbances,
- **modelling** of changes in the quality of the environment, in goods and services produced by ecosystems, according to various spatial and temporal scales
- **proposals** for methods to manage, preserve and restore natural and anthropised environments,
- and finally, **work towards** the establishment of a regional partnership between the research laboratories, SMEs, local authorities and those responsible for managing the area, in order to preserve the environment.

The Federation's strong points, are the following:

1 - A very considerable federating and structuring effect

The Federation brings together almost all the scientific community working in the environmental sector in Clermont-Ferrand, meaning over 300 people working in 16 different research laboratories under the aegis of various organisations (UBP, CNRS, INRA, VetAgro Sup - Clermont Agronomical Campus, BRGM, etc).

2 - Multi-disciplinarity really implemented

The structure encompasses a very broad potential for multi-disciplinary research, with complementary skills capable of opening the way to an integrated understanding of how natural and anthropised systems operate. Currently a multi-disciplinary approach is put to concrete use with the development of **5 transverse research actions** systematically involving several disciplines and several laboratories.

3 - A very high level of complementarity of skills available

Thanks to the complementarity of skills available locally and in the environments under study (atmospheric, aquatic and terrestrial systems), it is possible to access the soil-plant-air-water continuum in order to study the main biogeochemical cycles of elements. To the best of our knowledge, this is a unique situation in France.

4 - Close connections between Research and Education

The Federation is backed up by further education courses matched to its scientific goals, with, notably, approval of 5 research or professional Master degrees in the context of the contractualisation applicable to universities (2008-2011) in the environmental sector.

5 - Sustained scientific production

The work carried out in the framework of research coordinated by the Federation has resulted in the publication of 175 articles in peer-reviewed journals for the most part in the 1st and 2nd quartiles for the disciplines concerned, during the period 2008-June 2010. These journals are considered as being respectively "major" and "important" publications in their scientific fields.

6 - Active organisation of scientific events

The "Environment Federation" not only represents an active expression of the multi-disciplinary approach at the service of an improved understanding of how the environment functions, but also hosts exchanges and discussions, notably by means of scientific seminars and the organisation of an international congress every other year.

7 - An area of work supported by strong demand from society

The subjects of research conducted by the Federation correspond to questions of major scientific interest, and also strong and very topical expectations from society in general. So all our work is aimed at obtaining potentially useful results for reasoned management of environmental resources. In this connection, it should be noted that two innovating enterprises belong to the Federation and that we maintain very close links with the Federation of Enterprises for the Environment and Innovation in Auvergne (E2IA).

8 - Well-established local positioning

The Federation supports Environmental research, which is one of the 4 research fields covered by the State-Region Projects Contract for 2007 - 2013, or CPER, and is associated with the "Excellence Cluster

on Environment".

The future

The environmental research Federation is a recent structure, with an ambitious scientific project and a positive impetus at present. So, while we want to keep the main structural lines along which it was created and operates, various changes have either already been initiated or are planned for the coming four-year term of contract.

The aim of these changes is to develop the Federation at various levels:

1 - Change in types of subject

To begin with we will draw on the five lines of research in which work started in 2009 and which receive support in

the CPER Environment research context. However, during the next four-year contract period these lines of research will necessarily change, and new types of action will enrich the potential of the research projects steered by the Federation. Generally speaking, with respect to the subjects, one of the significant changes will be the increased importance of the Human and Social Sciences aspect and the development of research at the "Territories and Environment" interface. In this field the METAFORT UMR (mixed research unit) (Cemagref, VetAgroSup, INRA) recently joined the Federation, and closer relationships with the Human Sciences Unit (MSH) of Blaise Pascal University were recently initiated.

2 - Structural change

For the next four-year contract, new units will be joining the Federation with the result that all the higher education and research establishments in Clermont-Ferrand will be directly involved with the structure. Integration of UMR 1273 METAFORT, effective as from 2010, will make it possible to reinforce the "Territories and Environment" aspect, as already mentioned above. In addition, among the research subjects of UMR A 1095 GDEC, which is also joining the Federation, those addressing the agrophysiology of cultivated annual plants and the management and utilisation of biodiversity quite naturally find their place in the three parts of the Federation's programme.

In the field of observation, we are considering setting up an "OPGEC" (Clermont-Ferrand Earth Physics and Environment Observatory) by reinforcing the existing OPGC (Clermont-Ferrand Earth Physics Observatory) (LaMP, LMV) thanks to the integration of new teams in various laboratories (LMGE, GEOLAB and the ICCF Chemistry and Environment line of work) which carry out observations in the environmental field. The goal is to coordinate and structure this work so that alongside the operational research structures (Environment Federation and laboratories) there will be a structure with the appropriate financial, technical and human resources to measure a certain number of environmental parameters on a permanent basis, and to manage efficiently the long-term series of data thus obtained, and use them for research.

3 - Technical change

One of the future goals of the Federation is to provide the Clermont-Ferrand centre with an integrated environmental hub of national importance. To this end a project has been drafted in the context of the "Excellence laboratory" call for tenders in the Investments for the Future programme. This project corresponds to the establishment of pooled facilities in the form of 9 modules accompanied by the creation of 9 design engineer posts, for a total cost of about 16 million Euro.

In addition, one of the Federation's main goals is to obtain specific staff, with priority given to administrative staff for the secretariat and management, and technical staff to set up common projects and manage the databases.

4 - Changes with respect to education

In this field, our goal is to have a coordinated Masters offer in the environmental sector in Clermont-Ferrand, to make the "Environmental Research and Education" hub in Clermont-Ferrand more well-known and attractive.

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