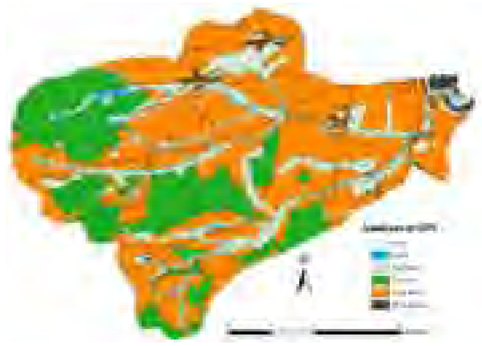

SUCCESS STORIES

CLIMAT – CLIMATE CHANGE AND CHANGE IN LAND USE IN LUXEMBOURG

During the 90s, the Grand-Duchy of Luxembourg was faced with a number of unprecedented floods. Since then, much work has gone into decreasing the hazard of floods, for example by restoring channelled river beds to their natural meandering course. Although such measures were generally successful, they were, more often than not, based on good guesses rather than accurate scientific data. The factors that can lead to flooding are manifold and their interrelationship is very complex. It is a fact however, that the changes in landuse that we have suffered predominantly since the second half of the 19th century, and natural as well as anthropogenic climate changes play a major role in the hydrological regime of our rivers.

Within the framework of the FNR's programme VIVRE, Dr. Laurent Pfister's team from the CRP Gabriel Lippmann and their collaborators from the University of Luxembourg and the Ecole Polytechnique Fédérale de Lausanne intended to shed light on these processes. Their project (CLIMAT - Climate and Landuse Changes in the Grand-Duchy of Luxembourg: Challenges for Land Use Management in Flood-prone Areas), which ran from 2003 to 2007, aimed to determine the relative weight of changes in landuse and/or rainfall contribution to the hydrological regime of the Grand-Duchy's rivers. Through the analysis of historical and current landuse and climate data, and its subsequent input into predictive models, they were to create flood hazard maps for the country's main alluvial plains, which, on a practical level, would provide valuable tools for the decision-making process of future landuse in areas at risk. In a further step, the data was to be used to predict the future runoff regime of our rivers in consistency with possible climate change scenarios issued by the IPCC (Intergovernmental Panel on Climate Change).

The initial phase of the project was thus devoted to the collection of data, resulting in a vast array of all kinds of datasets, which painstakingly had to be digitalised, standardised, validated, and finally, had to undergo statistical analysis. Several trends were crystallised out in the second phase of analysis: daily thermal amplitude and

mean annual temperature in Luxembourg have significantly increased since the 1950s, respectively the late 70s. Westerly atmospheric circulations have increased their winter frequency threefold over the past three decades, resulting in increased winter rainfall, and, as a direct consequence, an increased winter discharge in our river systems. Both the mild temperatures and the higher precipitation rates are associated with a positive NAO (North Atlantic Oscillation). Climate variability due to changes in the general atmospheric circulation patterns (Großwetterlage) is in its basis a natural phenomenon; anthropogenic alterations to these vast pressure systems are sure to exist, but have not been quantified as yet. But what effect would all these factors have on our rivers and their hydrological regime?

Insufficient datasets and the sheer number of variables make accurate predictions in climatology and hydrology virtually impossible. There will always be known uncertainties, such as lack of data or incomplete data. For example, if one considers a hypothetical hydrological station where water levels are to be measured once a day, one is

sure to gather a vast amount of data, but the chances of actually recording the peak levels are very slim. One of the failings of the IPCC models that were used in the CLIMAT project was their lack of specificity: they were programmed on regional grid quadrants with a surface of 500 x 500 km, which is, in effect, meaningless to predict any changes in the Grand-Duchy alone, especially if one considers that topographical obstacles can have a major impact on the local scale. As such, Dr Pfister and his team found clear differences in the rainfall and hydrological regimes between the western and eastern borders of our country, due to the orientation of the dominant orographic obstacles.

"Within the scope of the CLIMAT project, we were unable to draw reliable conclusions concerning future hydrological regimes" says Dr Pfister. "The datasets available to us were not strong enough and computers did not yet have enough capacity to run locally applicable models either. But we have gained valuable knowledge in the domain: most importantly, we have identified many of our so-called known unknowns, and are currently working on the quantification of these uncertainty factors. Technology has evolved and the climate models themselves have undergone further development. The IPCC models are nowadays being fed into regional circulation models (RCMs), which, in their turn, are being fed into local models (LCMs), allowing for much more precise predictions on the small scale."

The CLIMAT project helped to organise the energies and skills deployed at national level by both public authorities (e.g. Administration des Services Techniques de l'Agriculture, Administration de la Gestion de l'Eau) and the CRP Gabriel Lippmann with respect to climate impact studies and eventually also contributed to the implementation of a national hydro-climatological observatory (www.hydroclimato.lu). Since 2004, these administrations and institutions jointly publish their complete hydro-climatological recordings, along with detailed comments on the meteorological and hydrological conditions that had prevailed during each year.

The team from the CRP Gabriel Lippmann is currently collaborating on Rheinblick 2050, a project that aims to develop climate scenarios for the entire catchment area of the Rhine river. Further work is conducted within the framework of the Interreg IV B project entitled FORESTCLIM, with a focus on the impact of climate variation on forest ecosystems. The team also benefits of funding by the FNR once more: the direct follow-up project of CLIMAT is called MAPRISK and focuses on the integration of the afore-mentioned uncertainty factors in flood-risk maps. "The experience we have gathered during the CLIMAT project has inspired us and opened up new avenues" says Dr Pfister. "For the FNR-funded follow-up project RAINCELL (new CORE Programme), we are going to combine rainfall measurements by weather-radar data with information gathered by telecommunication masts. This should result in very good spatio-temporal data and thus help to further reduce uncertainties in the monitoring-conceptualisation-modelling sequence of hydrological research."