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ANFAS – Data Fusion for Flood Analysis and Decision Support

When there is a risk of flooding, decision makers have to decide what are the most appropriate reactions: evacuation of the population, reinforcement of dykes, etc. The ANFAS project aims to develop a decision support system for flood prevention and protection, integrating the most advanced techniques in data processing and management.

Large-scale flooding is a serious problem in many parts of the world. In Asia, countries such as China and Bangladesh regularly suffer, while in Europe many countries are at risk. There is danger of loss of life and serious damage to the economies of the areas affected.

For this reason, the ANFAS project has been set up to include partners from Europe and China. The partners bring together expertise in remote sensing, scientific computing, computer vision, internet technology, geographic information systems, knowledge-based systems, soil sciences, and other areas.

When there is a risk of flooding, decision makers have to decide the most appropriate actions to take: evacuation of the population, reinforcement of dikes, intentional breaking of dikes, etc. The aim of the ANFAS project is to develop a simulation and prevention tool to help decision-makers take decisions that will limit flood damage.

The ANFAS project will use data from the most advanced acquisition technologies. In particular, remote sensing imagery – optical radar, interferometry radar – will be incorporated in a conventional Geographical Information System database. Advanced data processing tools for scene modelling and flood simulation will be developed. Computer Vision and Scientific Computing will be used together in order to take into account information extracted from real images for the calculation of parameters of the simulation model. The project will have strong end-users involvement through the definition of the objectives, the design of the system and the evaluation of the simulation results. It ensures that the System answers to 'terrain needs' and is well adapted in practical use. Industrial partners are involved for the implementation of the final system. One of the main characteristics of the system will be its modularity, i.e., it will be composed of easily interchangeable blocks.

Floods regularly cause life loss and damage like here in France in 1999. The aim of the ANFAS project is to develop a simulation and prevention tool to limit flood damage.

The functionality of the ANFAS system will be:

- to perform flood simulation, simulating water flow propagation based on scenarios. The user will be able to interact with the scene that models the real site in order to add/remove dikes or other human constructions
- to assess flood damage. Flood assessment can be done either using the simulation results or using the remote sensed images of a real flood event
- at a prospective level, to analyse floodplain morphology including changes in riverbed and subsurface properties due to repeated floods at a given site.

The output of the system will be:

- visualisation: consisting of two-dimensional maps of the extent of the flood. If simulation is performed, time sequence maps tracing the propagation of the simulated flood will be provided
- direct impact assessment, evaluation of the total affected area
- regional and statistical analyses over the affected area
- simple socio-economic assessment of damage directly caused by flooding.

Pilot Sites

The ANFAS Information System will be applied and validated on three pilot sites: the Vah river in Slovakia will be used to set up the method and the system; the Loire river in France and the JingJiang Reach in China – along the Yangtze River, 80km dowstream from the Three Gorges – will be used to validate and consolidate if necessary, the developed approach.

For these sites, the scene modelling (geometrical and photometric modelling) will be entirely achieved. This means that each site will be computationally described as a geometrical three dimensional surface, completed by a

multi-layer description of the underground (e.g., geology, hydraulic properties of major aquifers and soil, units, urban regions, forests, fields, reservoirs, dike positioning) and the upper ground (rainfall rate). This description will be done at various scales, depending on the type of the feature, the exact localisation and the available data.

ANFAS is a research project coordinated by ERCIM

The Partners:

- Bureau de Recherches Geologiques et Minières, France
- CLRC, United Kingdom
- IACM-FORTH, Greece
- INRIA, France
- Matra Systemes & Information, France
- Slovak Academy of Sciences, Institute of Informatics, Slovakia
- University of Reading
- Chinese Academy of Sciences, Institute of Automation
- Chinese Academy of Sciences, Institute of Remote Sensing Applications
- Chinese Academy of Sciences, Institute of Atmospheric Physics
- Wuhan University, China
- Yangtse River Water Resources Commission, China

Duration

1 January 2000 -
31 December 2002

Budget:

4 280 000 Euro

Funding Agencies:

- European Commission, IST Programme: 1,600 000 Euro
- Chinese Ministry of Science and Technology: 1 000 000 Euro
- World Bank: 245 000 USD

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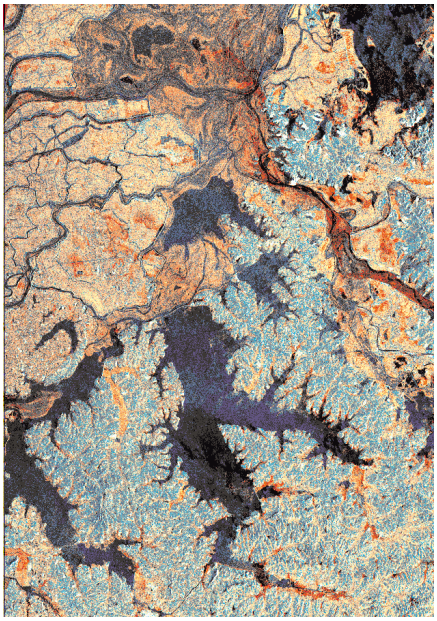
The choice of the sites is motivated by the similarity between them: they are in a natural state where their beds have not been entirely reconstructed. The major difference between China and Europe is the size of the sites: very large in the first case, much smaller for the second one.

Floods are the result of various factors including: short duration heavy rainfall upstream, long duration low intensity rainfall, failure of dams or dikes or snowmelt. In Europe, the floods are at the end of the winter season, generated mostly by snowmelt; in China, on the contrary, flood period is currently at the beginning of the summer due to the heavy rainfall.

In Slovakia, flood protection and problems of flood control are among the most important and also challenging tasks of hydrologists and river engineers. The Var river has a mean discharge of 175 m3.s-1 and the annual mean rainfall is 926mm It is heavily influenced by river training, dam construction, hydro-power utilisation – mostly derivation schemes with lateral canals and abandoned original river bed.

The Loire river in France will be used to test the developed Integrated Information System. A large part of the river (450 km), called the middle Loire, is characterised by a high gradient, a sandy and mobile bed, continuously reworked by the river and a man-made transformed bed, 500 km of dikes being located along this part of the river. These dikes delay flooding of the neighbouring valleys and form an artificial boundary threatened by the river in each high water-flow period.

These facts are responsible for high currents at high-water and an important erosion and sediment transport capacity. A numerical model of the middle Loire was developed in 1997 by an engineering company. The model is based upon the detailed topographic features of the most important hydraulic structures including dikes. The result of the ANFAS simulation will be compared to the results from this already existing model. This test and validation will be done with Plan Loire Grandeur Nature who will provide the (Graphical Information System) GIS data and the Digital Elevation Model (DEM) for the requirements of this application and who might run specific simulations for the assessment of the ANFAS Information System.



Colour composition from radar images, Poyang Lake, China, 1995.

The sites in China is located along the Yangzi river which has many important afluents and deposits large amount of sediment. Its flow can reach 75000m3/s (1931, Wuhan). During summer, part of the excess water is diverted into the Dongting and Poyang lakes, which play a natural reservoir role. But their capacity is most of the time insufficient.

The Three Gorges dam, to be completed in 2009, will regulate the water flow for flood control. The Three Gorges is of particular interest to the project in order to simulate the voluntary flooding of the filling phase of the reservoir. The size of the reservoir leads to many difficulties that the system may be able to predict.

Expected results

At the end of the project, the final result will be:

- An Integrated Information Systems adapted to end-user requirements consisting of three sub-systems as described below.
- Three sub-systems: (i) a Geographic Information System (GIS) (ii) Tools for Scene Modelling from Images and (iii) a Flood Simulation Model.

The final system will be an immensely valuable tool in planning national and regional responses to the threat of flooding, and will be adaptable to other areas.