tempQsim news

Perceptual models

providing the essential framework for understanding temporary streams

Ways of understanding water quality dynamics

Discussion of Perceptual Models, a **successful mid term review** and **additional laboratory experiments** are probably amongst the most relevant recent news.

The common development of perceptual models, the detailed “philosophical” description of water quality dynamics will provide a central platform for the future work.

Even under the tremendous pace set by the EU-WFD both practicers and scientist are being far from having an universal final picture of water quality dynamics and applicable management options in Mediterranean Catchments.

With its considerable scale, the project will meet the challenge to continue both fundamental studies as well as using the experience to support the end-users in practical issues.

In the Mediterranean countries of the EU, about 180 million inhabitants are affected by low river flows. For Member States facing recurrent and increased shortages alternating with periods of flood, the availability of suitable tools for the assessment and management of water resources is of great importance. This project is aimed at promoting a more efficient river basin management in semi-arid regions of the EU, where valuable water resources are both reduced and irregularly distributed in space and time.

Tributary to El Albujon study site in South-East Spain (UED)

Temporary or ephemeral streams are water bodies that experience a recurrent dry phase of various duration and spatial extend. It is difficult to apply knowledge and models to temporary rivers, which have been developed for permanent flowing rivers.

Implementation of the EU-Water-Framework-Directive and the future design of efficient measures require gaps in our knowledge of temporary stream functioning to be filled.

Main problems to be solved for implementation of the Water Framework Directive are:

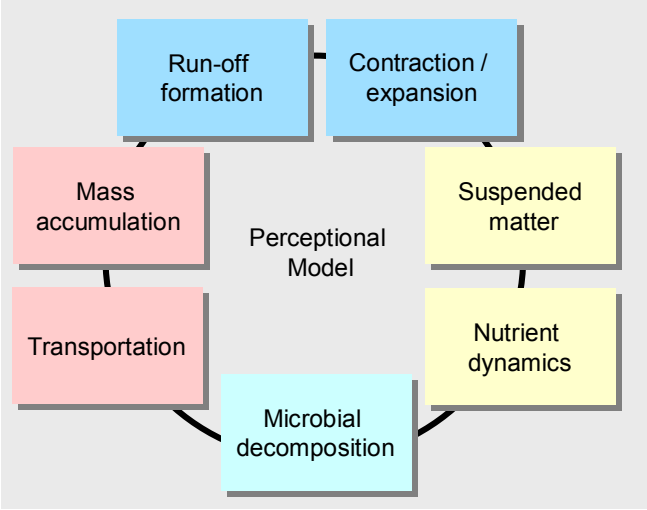
- the quantification of real pollutant loads
- the extreme concentration of pollution loads within short time intervals and long intervals between significant events
- the derivation of management options to meet the consequences of these events

Therefore, a major activity of the project is now related to the development of common perceptual models for the study catchments. The further understanding of run-off generation, storage, and routing, and its role in the mobilization, transformation and transport of both sediment and nutrients, are considered as key elements in providing necessary background information on management options.

In general a number of important periods have to be distinguished:

- dry period: terrestrial accumulation
- flood period: resuspension/ transportation to outlet
- transient periods: run-off only in some parts, transportation only within the catchment

Midterm-meeting discussing the key issues



During the Midterm-Review-Meeting which took place in Spring 2004, the discussion highlighted a number of key issues which the future modelling and experimental work will be focussed upon.

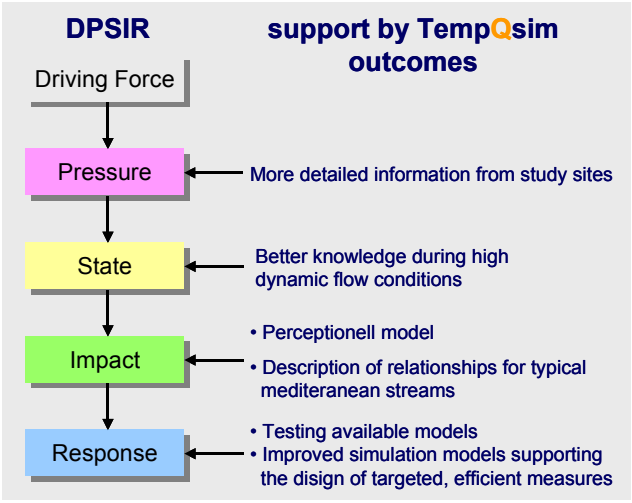
Supporting the EU-WFD

Being part of the Catchmod cluster, tempQsim addresses the detailed implementation of the EU-WFD in the Mediterranean.

The project issues are relevant for several topics of the DPSIR approach, which have been adapted as a Framework for the Directive's implementation.

In addition, the associated end-users of the project expect to receive support in identifying adequate monitoring strategies. This is of particular importance, as in temporary streams relevant data availability may be scarce.

A stronger link to the Pilot River Basins will be sought. As two of eight project sites are associated to the PRB's there is already an important interface available for the collaboration with corresponding organisations.



Scientific achievements

WP2 Model testing

The work programme of the TempQsim project can be roughly divided into three steps: a first phase of testing the unmodified models, with the consequent assessment of the strength and weaknesses of all the quantification tools regarding their use in intermittent river catchments, a second stage during which knowledge is built from field work results to be the basis for model improvement and finally, the modification of selected models to incorporate the "TempQsim modules".

During the testing phase the following models have already been applied to appropriate test

catchments: Cascade, SWAT, HSPF, PESERA, Athys-Pol, Topmodel and Eurosem. Some delays have been experienced. These were due to difficulties in gathering data, mastering new models and, in some cases, replacing some of the test catchments. The modelling activity has been carried out in a collaborative way. The Institutes are sharing their expertise in the use of the selected models. They are also giving assistance to each other in both developing the required environmental databases and in running/calibrating the models.

During the last project meetings (in Brussels and in Cagliari) the strengths and weaknesses highlighted in the models have been reported.

A first conclusion of this work is that run-off and erosion generation should be optimally based on a sub-daily (probably hourly) time step, due to the stormy behaviour of rainfall (large amounts of rain in few rain events), which is quite common in semi-arid areas. Also a dense network of rain gage should be available, due to the high spatial variability in the distribution of rainfall. In water scarce environments in which there are rivers that only flow intermittently, it is a common observation that monitoring/gauging stations often record only basic daily data. A compromise therefore needs to be found between the optimal desired time step in modelling and the common time/spatial density of available data.

Also water and sediment routing should be based on calculations made on sub-daily basis.

A second conclusion is that accumulation of readily mobilized solids during the dry period is not currently included in available models, and this leads to difficulties in forecasting resuspension in first flush events. This is part of a more general need to give fuller consideration in models to the reactions occurring at the channel bed. Also modules that account for processes in bed sediments during the time lag between the floods are largely missing and are considered essentials for the assessment of the water quality during flush events.

WP 3 Hydrology

> "Water scarcity is unfortunately strongly correlated to data scarcity",
> Statement from the tempQsim-Midterm Review

A dense watershed-monitoring network has established in each watershed in order to study the river hydrology. Water velocity and river cross flows are measured and water samples are taken at these points on monthly basis. Water samples are analysed for the estimation of their physicochemical characteristics and the concentration of the chemical species of carbon, nitrogen and phosphorous.

In addition the Greek partners have carried out in situ infiltration experiments in different landuses, lysimeter studies and groundwater studies.

A number of automatic gauging and meteorological stations in eight study catchments in Portugal, Spain, Italy, South-France, Greece and Bulgaria are being operated to provide new data. Intensive additional measurements of water quality parameters have been made during the Episodic Rain Event in the autumn and winter of 2003/2004. This will extend the understanding of water quality dynamics, especially for smaller and medium size rivers in the Mediterranean. This scale of river is of particular relevance as, for example, TU Crete estimated that 40% of the Greek land area drains to the sea through such river types.

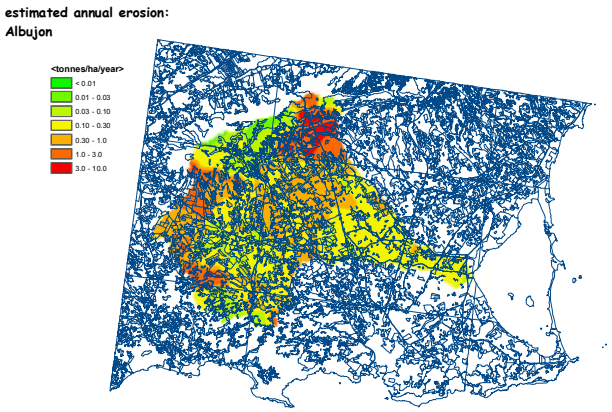
Application of standard water quality models to semiarid areas runs into two main problems:

- When and where does the first flush occur?
- What is the origin and quantity of the first flush?

The water quality is directly associated with the occurrence of run-off. Precipitation does not always lead to run-off, either in the entire basin or in parts of it. Without run-off there is little transportation. The period between runoff events is characterised by accumulation of deposits as 'slugs' of material, both on the catchment surface and within the channel.

Output of sediment-bound pollutants is strongly linked to detachment of sediment, particularly from agricultural areas within the catchment.

Links to the former Medalus project through the University of Leeds is providing information on the large-scale estimation of erosion loss from catchment areas. This will be used in the TempQsim modelling inputs.



Erosion prediction for the Spanish study El Albujon (ULEEDS)

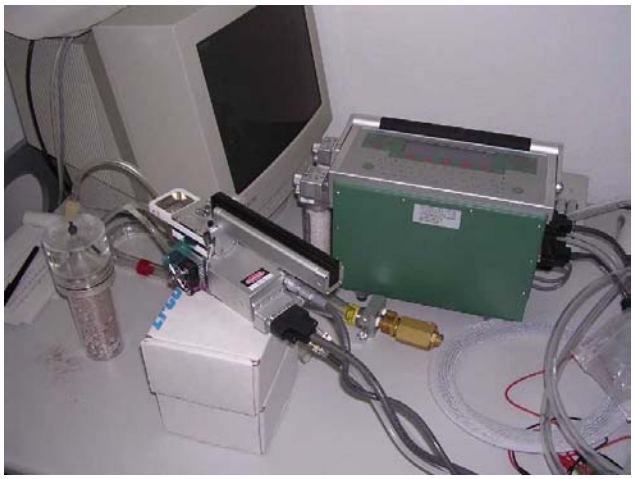
In semi-arid areas, there is an additional major influence upon water quality due to re-entrainment of channel bed material, particularly during 'first flush' events. Our initial data from the floods of last autumn reveal considerable diversity in both dynamics and measured concentrations.

WP 4 Sediment processes

One important issue for the project is the question of how much pollution potential is reduced or increased by in situ biological transformations between significant run-off events.

Therefore laboratory experiments are performed which are based on microcosm simulations in order to evaluate the impact of drying and rewetting on biological activities. Eventually a lower threshold for bacterial activities, with respect to sediment water content can be determined. Sediments from four catchments (Mulargia, Tagliamento, Degebe and Krathis) are being tested together in the IRSA laboratories in Rome. These analyses are also expected to provide information on the rates of organic matter degradation, in relation to moisture content, sediment composition or origin, together with community behaviour in terms of abundance and diversity.

In Krathis basin at reach scale an extended sediment characterization has been established (bulk density, soil moisture content, pH, porosity, BET surface area, particle size distribution) In addition the protocols are developed for the study in the laboratory of the Mineralization study and the Leaching studies. Respiration experiments have been carried out in situ.



(Measuring sediment respiration under different hydrologic conditions using a LICOR-gas chromatograph (EAWAG)

WP 5 Model improvement

In consideration of a range of modelling tools for different applications, the model improvement phase will address mainly two classes of approaches:

- Event-based models
- Deterministic, continuous models

With regard to event-based models, the University of Leeds is coordinating the development of the PESCAS model, which will include the combination of the PESERA model with specific event-based approaches for pollution leaching and transport. This concept will allow the inclusion of coarse-scale erosion predictions and so show some of the explicit effects of land use management on mass transport to the outlet points.

The family of deterministic continuous models provides a range of contrasting approaches with major differences both in their hydrological routines and in the concepts used to forecast sediment water interactions. TempQsim will make a significant contribution by providing a more comprehensive theoretical description and comparison of approaches implemented in the

selected models. These approaches may then be applied as a simple model or embedded in a more complex model.

IMAR, which leads the modelling improvement workpackage, is developing a module-based modelling approach. This will also provide a potential platform to integrate or adapt the individually developed modules. In a later stage, links to the ongoing Harmon-IT project will be used to decide which options in modelling development strategies might be of use for the tempQsim project.

Sampling of exceptional run-off event (CSIC-CEBAS)

Case study sites

River Degebe (Portugal)

Research at the Degebe is mainly focused on the quantification of mass-transport and the interaction with ephemeral pools. After problems in operating the automatic sampler, the preparation for the next flood period in winter 2004/2005 is of vital importance. Results of denitrification experiments will be presented at the next project meeting in Sofia. Personnel links between both AQEM and STAR projects, and IMAR limnological research have provided an important interface in considering the functioning of the ecosystem.

El Albujón (Spain)

This is an excellent example of successful sampling of very rare events! Given that this is the driest study site of the project, there was always the risk that there would be no flow met during the study period.

Two significant flood events have occurred during the period covered in this report, in November 2003 and April 2004. Both of them were intensively manually sampled during both the rising and falling limb of the hydrograph. All water samples and sediments during both flush events have been subjected to chemical analysis. These results show an increase in nutrient values and organic carbon at the beginning of the flood and a decrease of those values through time.

Vallcebre (Spain)

With access to long-term existing instrumentation, the well-equipped research catchment of Vallcebre is used to analyse fundamental hydrological conditions. Major results, which have also been reported to the last EGU conference in Nice, point to the difficulties of the models in distinguishing base flow and overland flow using only run-off data at the calibration. Using other information as water table levels or the extent of saturated areas drastically narrow the range of uncertainty. This will help in the consideration of different flow types appropriate to nutrient release models.

Vène (France)

This study area also has the advantage of being previously equipped with automatic samplers. The results obtained at the Vène catchment are now used to demonstrate the effect of short-time variability in loads of nutrients and suspended matter.

The river discharge fluctuates considerably over the year and is characterized by temporary flows in its upstream part.

High water table during flood event near the Vène outlet (HSM)

Point-source pollution consequently has different impacts depending on the hydraulic regime. During low water periods, in July and August, pollutant levels are very low at the basin outlet and are exclusively due to point-sources inputs. Conversely, during autumn and winter, intense storm events and flash floods occur. Floods have significant levels of pollutants that are due to the pollution brought to the river by surface runoff and to the removal of polluted sediments previously stored in the riverbed.

For instance, in the first flush flood of September 2003, half of the nutrient load originated from STW effluents which had been stored in the riverbed during the 4 months of the drying period, and which was suddenly exported out of the catchment.

A detailed perceptual model has already been set up and forms the basis for the model improvements for the ATHYS-POL and the CASCADE model. Inasmuch as MSEM has a close association with its regional end-user organisations, it is anticipated that studies on the Vène will also contribute to practical management options.

Mulargia - Flumendosa (Italy)

A water deficit of 30% and pressing risks of toxic algal blooms set the background for finding management options in the Mulargia torrent, a typical temporary river of Sardinia.

The study results so far obtained by Hydrocontrol and EAF confirm the importance of the pollution loads in the first flush events. This was illustrated by frequent samples taken at regular intervals during the first flood, which showed that the effect of pollution loads on stream water quality was less after the first flush, even when higher flows were recorded.

The application of SWAT (IRSA) and Athys-Pol (HSM) will provide additional detailed knowledge on the most appropriate resolution in sampling frequency for the requisite hydrological data..

Fiume Tagliamento (Italy)

The Tagliamento River is being studied intensively by the EAWAG, which leads the research on channel bed processes. Currently the main focus is on describing contraction and expansion dynamics, as well as determining the rate of organic matter decomposition.

In the Tagliamento catchment, approximately 55% of the entire stream channel network is seasonally dry at the surface. In first- and second-order streams, headwater surface drying is a natural phenomenon. However, in higher order segments it is mainly due to water abstraction for irrigation and hydropower production.

During summer 2003, between 3 and 22 km of the river dried up. Frequent irregular flow pulses, caused by storms, rapidly increased the length of the wetted channel (up to 3 km/h); the subsequent contraction was much slower (≤0.5 km/h).

Unique picture of the flood front at Tagliamento (EAWAG)

The natural inundation regime is a pivotal factor, which dictates the structure and function of river-floodplain ecosystems. Its most significant determinants include the frequency, duration,

and timing of drying and rewetting. A fundamental ecosystem process in river-floodplain systems is the decomposition of organic matter, which strongly influences ecosystem dynamics through the release of organically-bound nutrients. Results of the litter-bag technique show that frequency of wetting and drying did not display a clear pattern. Therefore, inundation duration rather than frequency seems to be important in controlling leaf decomposition in this river-floodplain ecosystem.

Krathis (Greece)

Current studies and a joint collaboration with the Ministry of Environment, Physical Planning and Public Works highlight the importance of the study site, which is representative of a large number of Greece basins. Plans for future use of the site as an experimental catchment are under discussion.

The results from past work at the Krathis catchment indicate the importance of high erosion and mass transport from the headwater area during the flood period. However, there is a need to gain a more precise understanding of the functioning of the hydraulic system.

The study of the In Stream processes has been focused on the reach scale studies.
1. Methodology applied in order to study ground water/surface water interaction at reach scale included installations of well clusters. These provided, *in situ* studies of the hydraulic properties of the river bed through pumping tests, injection withdrawal tracer studies and infiltration experiments) and laboratory studies to evaluate the hydraulic properties of the riverbed.
2. The study of the expansion and contraction dynamic of the river at reach scale. NCMR mapped the area and takes aerial photos on monthly basis. Using GIS is going to estimate the portion of the river that is wet and the portion that is dry in relation to the flow.
3. The study of the hydrogeochemical processes of C, N, P at reach scale. Both teams from the Technical University of Crete and NCMR Athens are working closely together to finalize a hypothesis and a perceptual model. The main results of the assessment of the N and P cycles at the reach scale have already been presented to the International Conference, Protection and Restoration of the environment VII, in Mykonos Greece, 28 June – 1 July 2004.

Together with the University of Essen, additional effort is being directed towards gaining more detailed information on local sources of organic matter and erosion dynamics. The data from the Krathis catchment studies has also been submitted to partners from EC-JRC so that future modelling studies of erosion dynamics using the ANSWERS 2000 model can be carried out.

The final objective is scaling up the processes from the laboratory and the points in the reach at the reach scale and to relate them to the expansion and contraction of the river and the wetting and drying.

Iskar (Bulgaria)

Progress in addressing the Sofia Water crisis has been made. After the successful construction of a monitoring station and infrastructure for sampling, the Iskar study site is now ready to support future progress in Integrated Water Resources Management in Bulgaria.

In-stream deposition areas at the Iskar River (UACAG)

Current model-applications and a wider survey of pollution pathways will help to identify best management practices in order to protect the Iskar reservoir, which is amongst the main water sources in Bulgaria.

The effluent from a large number of in-habitants whose dwellings are not connected to waste water treatment plants affects the Iskar. In addition to the standard analyses, the partners from UACEG are also studying bacterial pollution and its effects in varying hydrological conditions.

Announcements

- **tempQsim Meeting** and field visit to the Iskar site, Sofia, September, 8-12th 2004.
- **TempQsim presentation at IWA World Water Congress and Exhibition**, September, 19- 24th 2004
- **2nd Harmoni-Ca/CatchMod technical Workshop,** Copenhagen, November 16-18th 2004

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