Evaluation and improvement of water quality models for application to temporary waters in southern european catchments

Results

Project Information

TEMPQSIM

Grant agreement ID: EVK1-CT-2002-00112

Project website

Project closed

Start date
1 November 2002

End date
30 April 2006

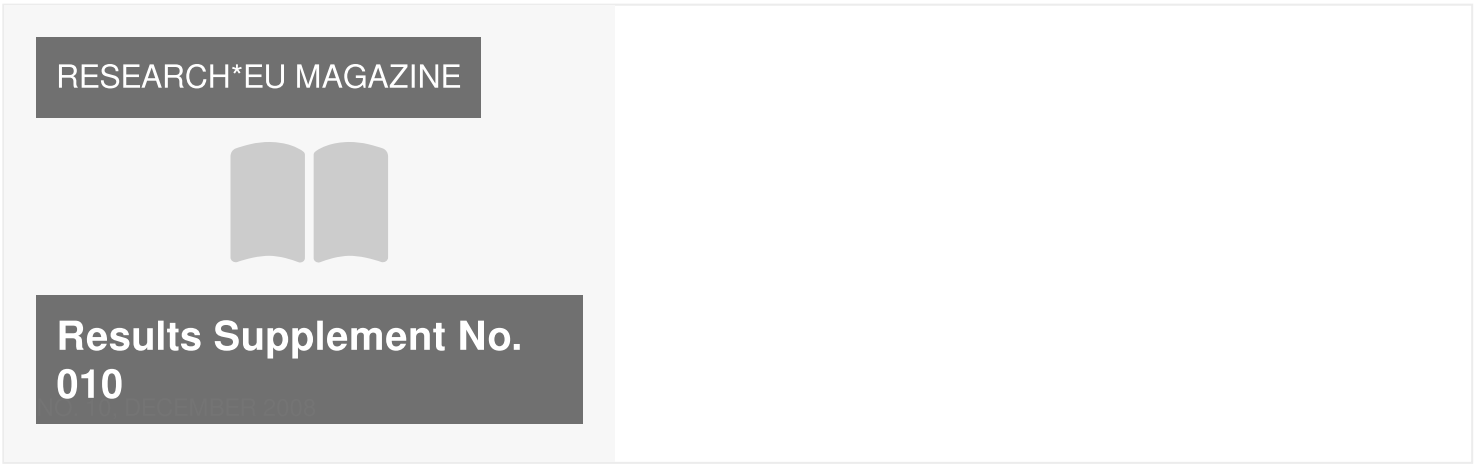
Funded under
Programme for research, technological development and demonstration on "Energy, environment and sustainable development, 1998-2002"

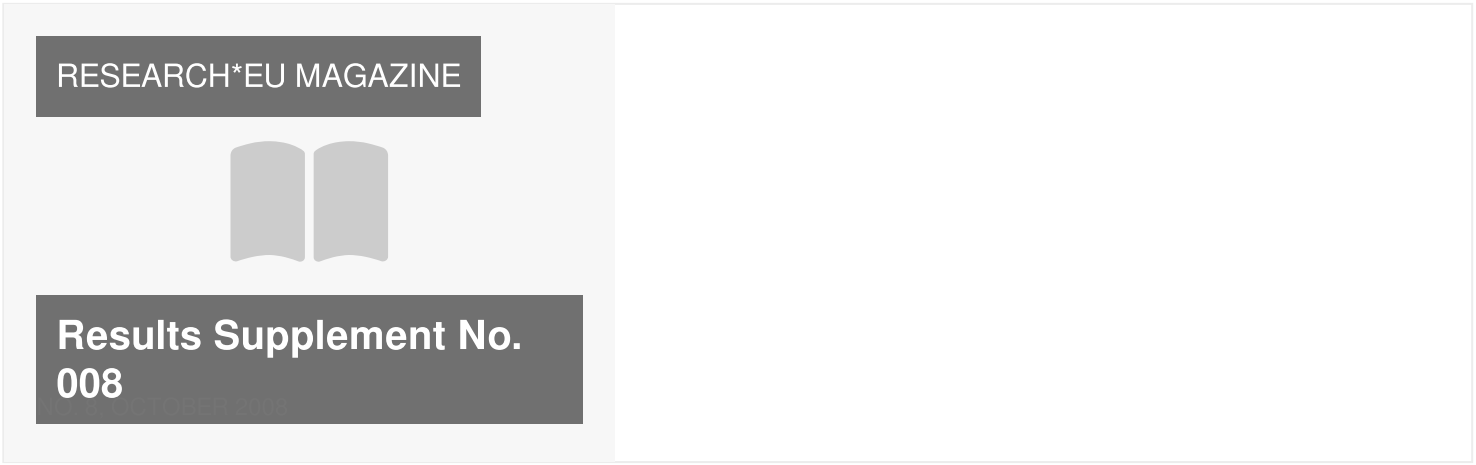
Total cost
€ 4 697 162,00

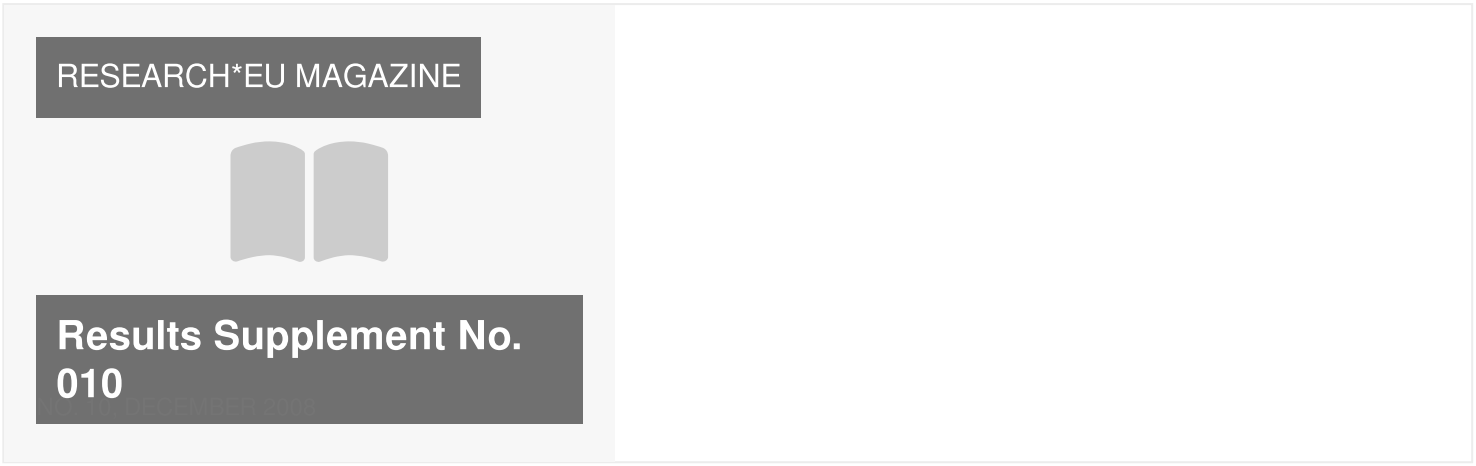
EU contribution
€ 3 071 421,00

Coordinated by
UNIVERSITAET HANNOVER
Germany

This project is featured in...







CORDIS provides links to public deliverables and publications of HORIZON projects.

Links to deliverables and publications from FP7 projects, as well as links to some specific result types such as dataset and software, are dynamically retrieved from OpenAIRE.

Deliverables

Report of tested water quality models for temporary waters

The models under evaluation within the tempQsim project range from continuous time hydrological models originally designed and suited for application to medium/large scale catchments to rather detailed and complex tools for application to a single slope. Models showed to be rather different in the detail of the output obtained as result of application as well as in the time scale characteristic of the model.

Since the beginning of the project in particular SWAT and HSPF models have undergone a process of improvement by the respective users/developers communities in several aspects. In the same time a coarse scale delivery model (PESCAS), an improved in-stream water quality model (tempQsim-STREAM) and a detailed biochemical reach model (tempQsim-REACH) were established and tested.

Improvements were related to a sub-daily time step for runoff generation and routing of sediment and nutrients (due to the usual fast response time of such rivers), an improved transmission losses calculation (quite critical in rivers with gravel beds), a better quantification of sediment transport along the slopes (to take into account deposition before the runoff enters the river network), an in-stream module that takes into account deposition-resuspension of sediments, the possibility of assimilation of radar weather data to try to overcome spatial variability of rain events.

Within the time boundaries of the project, two developments within the SWAT model took place and have been tested on the Mulargia test site (a) sub-daily time step for water balance simulation and polluting load routing, (b) sensitivity analysis and autocalibration. The adoption of the subdaily time step lead to a significant improvement in the simulation of the peak flow.

The application of the HSPF model to the Krathis River revealed several weaknesses related to heavily modified systems, karstic base-flow, dry-wet/ expansion-contraction dynamics, first flush effects, biogeochemical processes under changing moisture conditions.

The tempQsim-STREAM model focused on two major features which distinguish the biogeochemical properties of temporary waters from those of permanent waters (a) ongoing biogeochemical processes in pools even after surface flow has ceased, (b) accumulation of organic particulate matter on the channel bed due to transmission losses. Model results show both the significant potential for mass accumulation within the channel system during the dry period, as well as the effects of the first flush.

The consideration of the drying and rewetting impact on biogeochemical processes with tempQsim-REACH was shown to be effective at the Krathis catchment and indicated a sufficient sensitivity regarding resuspension of sediments. Current results for the particular case of the Krathis catchment indicate that changes in nutrient concentrations within the reach are significant during low flow conditions, whilst during the flood events, pollution dynamics are largely driven by the variability of inflow to the reach.

The results of PESCAS show basically a distinct seasonal variability especially for the Krathis and

Degebe/Pardiela and the Vène catchment. The model indicated also an added value for upscaling the project results and estimating the relevance of dry streams at an European level.

Relevant sediment processes and water quality interaction at temporary streams

The scientific knowledge for sediment processes and their interaction to water quality in temporary streams provides the scientific basis for developing sustainable environmental flow requirements. The main aim of this result is to quantify the extent to which surface drying and rewetting determine in-stream sediment processes (storage, transformation, and remobilisation of organic matter and pollutants), and how these processes influence downstream water quality.

Partners UDUES (sediment analyses) IRSA (microbial activity), TUC and HCMR (mineralisation, leaching), EAWAG (respiration, upscaling), IMAR and UACEG contributed to the cross-comparison and laboratory experiments.

Across the Southern European catchments four temporary rivers located in different Mediterranean regions and typically characterised by a substantial intermittency of the water flow were studied in depth including Sediment characterisation, Bacterial Carbon Production (BCP), Mineralisation capacity, and Sediment respiration: The River Tagliamento (Italy), the River Krathis (Greece), the Mulargia, and the River Pardiela.

The four rivers differed considerable in their chemical composition. Degebe was the enriched in organic matter (AFDM) and in TOP, while the Tagliamento was the most nurient and organic matter poor river. Related to the Bacteria Carbon production, the results showed that the overall responses to drying of the bacterial community were independent from sediment origin and strictly related to water content. The mineralisation capacity was depended on the organic matter content and to a minor extent on the sediment moisture content.

Increased soil moisture content increased the mineralisation capacity of the sediments. Respiration varied significantly among habitats, over time and incubation temperature. After six hours of inundation respiration rates were highest for the floodplain forest followed by the large wood accumulation and gravel habitat at any incubation temperature. Temperature explained a high proportion of the variation of respiration. We expect that natural temporary streams provide multiple services including the provision of clean drinking water, the self purification of waste water, the recharge of ground water, the provision of habitats for a rich terrestrial and aquatic fauna and flora, as well as cultural and aesthetic values. A natural flowing and drying regime is required to maintain these services.

The results demonstrate that the effect of inundation duration, following a rainfall pulse, controls the process diversity within the channel. Very short pulses, as characteristic for low-order stream segments, leach nutrients, which again increases instream productivity further downstream. The relative extent and the dynamics of the temporary channel network within a catchment may therefore

influence the capacity of the rivers to produce, transform, and store nutrients and organic matter.

The major dissemination of the results is made by publishing the synthesis article "Heterogeneity of Ecosystem Processes in Temporary Streams: The Role of Drying and Rewetting" as well as a number of additional specific papers.

The expected benefit is mainly related to a more adequate consideration of dry land ecosystem functionning in the watershed management and the implementation of the Water Framework directive, as well as to the determination of suitable minimum flow conditions for semi-arid streams.

Perceptual models on hydrological dynamics and water quality in temporary streams

Hydrometric data has been collected within the project for the seven test catchments. The data has been collected at least for the period from Summer 2003 until the revised end of the project in early 2006.

The Data are archived by catchment managers and centrally, it will be published as appropriate through the scientific literature.

The data collected are archived centrally in the tempQsim-data base, accessible via the project web-site www.tempQsim.net.

The data represent up to now a rare and unique collection of varying aspects in hydrology and water quality. There are no comparable situations known with a similar richness and diversity related to different conditions of catchment geography and anthropogenic pressure.

It is agreed that a) the use of the raw data will be restricted to the consortium partners, as they are partly complemented with individual data belonging to the data holding institutes or related enduser organisations, which makes a free dissemination difficult, b) the scientific reasonable use of the data is only possible within a given context of accompanying hydrological knowledge and c) the data provide a competition advantage for upcoming RTD activities. A copy of the data base is provided to the EC.

The use of these data will be predominantly within the ongoing research in the field of temporary streams on a billateral or multilateral basis by the project partners.

The public access to the information gathered is enabled via the scientific literature. Therefore a specific discussion of water quality dynamics is given in individual publications by describing the perceptual model for each study site.

Corresponding manuscripts are available for all study sites and will be published depending on the progress of the review process.

Meta Data of tempQsim

The resulting field data of the tempQsim project are achieved corresponding to a Meta Data description, which are accessible on the project web-site.

The Meta data structure considers the required flexibility allowing a continuously completion of data bases.

The Meta data description will be made public available, to support a future harmonisation of data structures and to give an example of the way it was used in the tempQsim project.

The Meta Data structure will also be used within the consortium to complete data sets in upcoming research activities.

Water quality modules and improved catchment models

TempQsim has comprised the model development under a pan-European collaboration of 14 participants and is supported by measurement programmes based on eight research catchments across the range of European dryland environments. The models have been applied and tested in the project test catchments and compared with both existing data and additional data collected during the course of the project. The resulting models were to be made available, with technical support, to the research community and end users as a tool for exploring the impacts of land use and climate change scenarios.

The tempQsim project aimed for the first time to make specific improvements to water quality models for application to temporary streams. In this way, tools should be provided to improve the integrated management of water resources in Mediterranean and other dryland river catchments through quantifying the water quality dynamics of these ephemeral and temporary waters and through the development of improved water quality models.

Experience gained during the tempQsim project indicates that the complexity of modelling in dry areas is associated with the high variability in space and time of water flows and pollution sources. The spatio-temporal scale selected for modelling affects the amount of input data required. One way of handling data acquisition and processing is to address different problems at different scales with different modelling tools.

The development of modelling tools addressed both the improvement of coarse scale delivery models as well as detailed in-stream and reach scale water quality models. Specifically, sub-models were designed to account for accumulation, remobilisation and transformation processes for organic matter and nutrients during the dry and wet periods.

The tempQsim tools outlined below are associated with decreasing scales from European scale down

to the reach scale. At this smallest scale, describing a part of the stream network, uniformed conditions may be assumed.

PESCAS is devoted to the simulation of sediment and nutrient delivery at regional scale, paying particular regard to difficult data availability at this scale. The PESCAS approach offers a methodology for long term management of water quality, focusing on spatial and seasonal differences at the Mediterranean scale and is designed to operate with a daily time step at the catchment scale. This approach is therefore less demanding in computing resources than a continuous time model running through each event. As land-use and climate are explicit within PESERA and CLINUM the sensitivity of changing environments can be explored.

tempQsim-STREAM is an in-stream water quality model which pays particular attention to transmission losses and mass accumulation during the dry period. It also takes into consideration relevant nutrient transformation and the production/decomposition of particulate matter. Special emphasis is also given mass balance during the onset of flow.

The tempQsim-STREAM model consists of a hydrodynamic model, which includes a non-steady state water quality and a benthic submodel. Instream flow routing is computed via approaches as Kinematic wave, Diffusive wave or Dynamic wave. It is designed especially for modelling problems where water is stored in pools, either naturally or following the input of waste water effluents. Therefore a special focus is given to the dynamic simulation of the change from dry to flowing conditions in the river, and the flood-induced reconnection of isolated pools to the stream. Special algorithms for converting concentrations into mass allow a reasonable treatment of accumulated pollutants during dry periods, retaining mass balance.

Using a specific numerical approach the model is well tailored for non-steady state conditions associated with flash floods and related rapid changes in river condition.

The tempQsim-REACH is a generalised model that can describe the hydrology, sediment transport and biogeochemical processes of temporary rivers at the reach scale. The tempQsim-REACH model simulates process dynamically during wet and dry periods with spatial accounting for the expansion and contraction of the river corridor. The model comprises hydrologic sediment transport and water quality submodels.

Spatially, the reach is represented as zero-dimensional simulating temporal changes in water quality due to biogeochemical processes.

Manual for supporting water managment of temporary waters and the Implementation of WFD

The results of the tempQsim project were summarised in a special booklet "Critical Issues in the Water Quality Dynamics of Temporary Waters, Evaluation and Recommendations from the tempQsim Project", also serving as a manual for interested endusers.

Experiences in investigating specific nutrient dynamics affected by accumulation during dry periods and release by flash floods were processed to recommend adapted monitoring, modelling, and management strategies.

The compendium comprises both lessons learned from the individual case studies as well as related to the overall themes. For all case studies a presentation and discussion of seasonal variations in nutrient loads is given as well as additional site specific information.

The description of the Pardiela watershed (Portugal) addresses the impact of remaining natural pools and the applicability of the tempQsim-STREAM model.

The description of the Albujon watershed (Spain) addresses the impact of severe aridity and the applicability of an adapted hydrological model for such conditions.

The description of the Vallecebre watershed (Portugal) addresses the experiences with testing TOPMODEL and TOPBAS, as well as the relevance of specific hydrological issues.
The description of the Vene watershed (Southern France) addresses the impact of waste water discharges to a temporary stream as well as the influence of the Karst system.

The description of the Mulargia watershed (Italy) addresses the applicability of the improved SWAT model.

The description of the Tagliamento watershed (Italy) addresses the impact of drying/ rewetting on ecosystem functioning.

The description of the Krathis watershed (Greece) addresses the hydrological dynamics at the reach scale and the applicability of the tempQsim-REACH model.

The description of the Iskar (Bulgaria)watershed is mainly introducing the interaction of lower and upper parts of the basin as well as the applicability of the HSPF model.

Related to the general applicability of models in temporary streams the booklet presents an overview of scales and associated processes as well as a basic characterisation of the models developed.

A revision of management options is provided as well as an outline of future relevance of temporary streams for water shed management at European Scale.

This booklet is a first approach to summarise key findings for managing temporary streams in an appealing way. It may be obtained as printed or electronic version (here also in high quality resolution).

Its main dissemination will be realised via the WISE RTD IWA dry area forum.

Last update: 9 December 2005

Permalink: https://cordis.europa.eu/project/id/EVK1-CT-2002-00112/results