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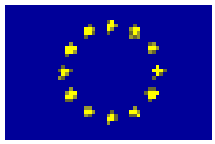

Project 018436

TWINLATIN

Twinning European and Latin-American River Basins for Research Enabling Sustainable Water Resources Management

Instrument: STREP

THEMATIC PRIORITY: GLOBAL CHANGE AND ECOSYSTEMS, TWINNING EUROPEAN/THIRD COUNTRIES RIVER BASINS

Executive Summary Report - Full Project Period

Period covered: from 1/09/2005 to 31/12/2008

Date of preparation: 15/03/2008

Start date of project: 1/09/2005

Duration: 40 month

Project coordinator: Sam Ekstrand
Project coordinator organisation: IVL Swedish Environmental Research Institute

Executive summary

Objectives

The strategic objective of TWINLATIN was to fill gaps in knowledge and methods in order to enable implementation of a harmonised IWRM approach in Latin American river basins, addressing the European Water Initiative and using the European Water Framework Directive as a guiding reference approach. In this context an important focus was to enable and perform assessment of climate change effects on the hydrological regime, water availability and water quality of the seven river basins. The project also addresses the objectives of the EU Water Initiative; improvement of water quality and availability for poor communities as a means to reduce poverty, enabling water authorities to propose actions that have been thoroughly analysed from all perspectives; surface water availability, surface water quality, groundwater availability and quality, sustainability criteria, as well as domestic, agricultural, industrial and hydropower stakeholder interests.

The pilot river basins in TWINLATIN were: The Baker river (Chile), the Catamayo-Chira river (Peru-Ecuador), the Cauca river (Colombia), Lago de Nicaragua (also called the Cocibolca lake, Nicaragua), the Quarai/Cuareim river (Uruguay-Brazil), the Thames river (UK) and the Norrström river (Sweden). The research and development work focussed on the Latin American rivers, but RTD was also carried out for Norrström. The Thames river was used as a reference case.

Decision making tools are needed in the Latin American countries and transfer of such tools have been a major objective of the project. Such tools are major components necessary for a successful analysis of climate change and human development scenarios, effects of measures and development of preliminary river basin management plans.

TWINLATIN focused on solving problems and priorities identified at local and regional level and on creation of networks for implementation of results. In this sense public participation and stakeholder involvement were key elements, assuring that the RTD activities focussed on local priorities. At the same time, the partners have been striving to create communication structures that can and will be utilised after the termination of the project.

Work performed and main achievements

The work within TWINLATIN was initiated in September 2005 and was finalised during the spring 2009. Work has been conducted within ten work packages, each resulting in a final work package report as well as other deliverables:

- WP1 Current Status and Stakeholder Structures
- WP2 Monitoring and database construction
- WP3 Hydrological regimes and Extremes
- WP4 Public participation
- WP5 Sustainable Management Strategies
- WP6 Pollution pressure and impact analysis
- WP7 Classification of water bodies
- WP8 Change effects and assessment of vulnerability
- WP9 Optimal Actions and their Socio-Economic Impact
- WP10 Twinning activities

All reports have been made available to the public on the project's web site (www.twinlatin.org).

The river basins in TWINLATIN are all medium-sized, ranging from 13.000 km^2 (the Thames basin), to 26.700 km^2 (the Baker basin). With the exception of the Cauca river the Latin American basins are transboundary. Transboundary issues were prioritised in the Catamayo-Chira and the Cuareim/Quarai basins, although also the Cocibolca and Baker basins are transboundary. The climatological characteristics vary considerably between the basins. Three

of them are temperate (Baker, Norrström and Thames), while the Cauca, Cocibolca, and Cuareim/Quarai basin are tropical/subtropical. The lower parts of the Catamayo-Chira basin is semi-arid. In terms of population the basins differ widely, from densely populated basins such as Thames and Cauca, basins with medium sized populations (from 600 000 to 1,5 million inhabitants) as Catamayo-Chira, Cocibolca and Norrström, and small populations as in Cuareim/Quarai (60 000) and very low in the Baker basin . The Norrström, Cauca and Catamayo-Chira are heavily modified by hydropower infrastructure. The Baker basin plans of building five hydroelectric power stations over the next fifteen years have created heated discussions in the country. Domestic water supply and associated water quality issues are important issues in the Thames and Cauca basins and increasingly so also in the Cocibolca basin with future plans for provision of drinking water to Managua city. Eutrophication is main environmental problem in the Norrström basin. Industrial, domestic and agricultural pollution are problem areas in four of the Latin American basins. The exception is the Baker basin which is still pristine. Erosion and sediment release is a major pressure factor in the Latin American basins, targeted within the project in the Cocibolca, Cauca, Cuareim/Quarai and Catamayo-Chira basins.

The extent and availability of existing data and monitoring infrastructure varied between the pilot basins. The report of WP 1 covers compilation of history, current knowledge, the status of the river basins regarding hydrology, water quality, water availability, used demands, political structures, policies, and stakeholder structures. This information was the basis for the execution of all work packages.

Early in the project it was agreed that IVL should look into the possibility of assisting twinning organisations in Latin America with the development of a common database structure based on ArcGIS/ArcHydro. During the first and second year, a number of information exchange and twinning events resulted in implementation of harmonised geo-database structure in the LA basins for the geographic/thematic information of the different case study basins.

The partners of the transboundary river basins in TWINLATIN, who include the managing authorities, have developed far-reaching strategies for assuring continued sustainable use of data and results after TWINLATIN. The Cuareim-Quarai river basin (Uruguay-Brazil) has been selected as a successful example for Water Resources Management between the two countries and the Local Coordination Committes created years ago are now working in a co-ordinated way and in line with Federal and State policies in Brazil and Uruguay. The Catamayo-Chira basin (Ecuador-Peru) is another successful example of coordination and cooperation between countries.

The project has substantially contributed to filling monitoring data gaps, thus allowing the partners to work with modelling, actions, climate change analyses, economic assessments, on a level of detail and quality that was not possible prior to the project. The monitoring conducted in TWINLATIN was incorporated in the plans and regular monitoring activities at the responsible national organisations, and have catalysed strengthened and extended monitoring plans for the coming years, after the project. This has been a major achievement of TWINLATIN. No further monitoring was planned in the Thames basin as part of TWINLATIN, while monitoring was carried out in Norrström, as a basis for improved nutrient modelling.

Figure 1: Cuareim/Quarai Bi-national water quality monitoring program under TWINLATIN. The program will continue after the project

At WP3 the problems to be solved and needs were identified, and therefore, the most urgent research activities under WP3. Table 1 shows the priority issues addressed during TWINLATIN generally, and WP3 specifically, and the future application of the modelling.

Table 1 Approach to hydrological modelling

Issue	**Baker Chile**	**Catamayo-Chira Ecuador-Peru**	**Cauca Colombia**	**Lake Cocibolca Nicaragua**	**Cuareim/Quaraí Brazil-Uruguay**
Area (km^2)	26,726	17,200	62,000	24,000	14,800
Transboundary?	Yes	Yes	no	Yes	yes
Why model?					
Current water uses	Water supply, irrigation, mining, conservation	Water supply, irrigation	Water supply, irrigation (coffee, sugar cane), industry (paper)	Water supply, fishing, navigation, conservation, tourism	Water supply, irrigation (rice fields)
Priority issues	Lack of data, glacier/ snowmelt issue, HEP development	Water demand, WQ/ sediment, reservoir siltation, deforestation, intensive agriculture	WQ, pollution from industry & intensive agriculture, waste disposal, water rights	Water availability, WQ/sediment, deforestation, intensive agriculture, waste disposal, navigation, water rights	Water availability, WQ, urban flooding, low flows/ droughts, small farm dams, water rights
Modelling applications	Land use/ climate change	Land use/ climate change impacts on WQ/erosion	Land use/ climate change	Land use/ climate change	Water resource scenarios, land use/ climate change
Data availability and modelling time interval					
Data availability	Very poor in Baker, mixed in amount & quality in BioBío	Poor amount & quality	OK amount of data, quality poor	Poor amount & quality	Global datasets available, local data mixed in amount & quality
Time interval	Daily	Monthly	Daily	Daily/monthly/ annual	Daily
Spatial scale	1 sub-basin of Biobío	Basin & 4 sub-basins	1 sub-basin	Basin & 1 sub-basin	Basin & 1 sub-basin
Model selection					
Choice of model	SWAT to Lonquimay sub-basin of BioBío to further develop snow/ glacier/ TWINBAS work	SWAT to 4 sub-basins in upper & mid basin, & outlet	HBV/IHMS to basin – for TWINLATIN work to Tulua sub-basin of Cauca	Simple WB & WASMOD WB for basin WATSHMAN-PCRaster in Mayales sub-basin & GLUE uncertainty	SWAT, MODSIM to Tres-Cruces sub-basin MGB-IPH large-scale distributed hydrological model to basin
Data requirements	Topography, met data, rain, snow, flow, land use, soils (daily)	Topography, met data, rain, flow, land use, soils (monthly)	Topography, met data, rain, flow, soils, veg (daily)	Topography, met data, rain, flow, soils (daily)	Topography, met data, rain, flow, land use, soils, veg, x-sections, reservoir & small farm dam data (daily)

where: HEP – hydroelectric power, WQ – water quality, WB – water balance, x-section – cross-section

Apart from the Baker basin, all Latin American partners chose to model the entire basin, in addition to at least one sub-basin usually selected by importance and/or data availability. Apart from the Catamayo-Chira case, all partners chose to model at a daily time step. In the end, six different hydrological models were used by Latin American partners under WP3, ranging from a simple water balance to a large-scale distributed model. At Norrsröm, the activities performed were addressing eutrophication of the Baltic Sea and Lake Mälaren (the latter provides drinking water for 1,5 million people). In order to improve the modelling of phosphorus transport in the Norrström basin, flow proportional measurements of P were conducted. Part of the modelling activities in the Norrström basin also focused on microhabitat modelling. The objective of this work was to assess biological quality indicators as habitat suitability for selected species of fish, useful in ecological status assessment.

A continental approach can provide a wider regional context for some of the problems faced, in particular water deficit. It can also provide an opportunity for climate change impacts to be examined and compared at the continental, regional and basin scales. Therefore, the Global Water AVailability Assessment (GWAVA) model was applied to the South American continent (excluding Nicaragua) enabling a broader regional picture of hydrology and spatial extents of water scarcity.

Strengthened Public Participation and stakeholder involvement was the main outcome of WP 4 and one of the main achievements of TWINLATIN. In all basins the WP 4 efforts have produced substantial advances in PP and SI structures as well as in the public and stakeholder awareness on water problems and the IWRM process. The participatory process conducted in WP 4 created spaces for dialogue and reflection among stakeholders and groups of interest of the basin, as well as between researchers and government officials. The main lesson taught by the process is that collaborative and coordinated work is the main way to address the complexity of the IWRM. As mentioned the partners of the transboundary basins have carried out the tasks of ambitious dissemination plans in their respective basin. The communication plans prepared during the first year of the project were implemented in all basins with some corrections and/or changes requested by stakeholders. Of special interest are the activities in the Catamayo-Chira and Cuareim/Quarai river basins, where the transboundary condition add another difficulty to water management. Gender actions were one the objectives at Catamayo-Chira project and a number of gender related meetings, workshops and other technical activities have been carried out in the basin, significantly strenthening the awareness of women regarding water related problems and their capacity and possibility to participate in the management process. A milestone in the TWINLATIN public participation efforts was the organisation of the international workshop " Public participation and gender in water Management". Co-ordinated by UNIGECC and IVL during May 2008 in Piura – Peru.

WP 5 focussed on sustainable management strategies. The current river basin management in the five basins differs, due to the diversity and complexity of the institutional and legal frameworks of the different countries. There are also important differences in their regional evolution and historical antecedents. Different management systems meet in transboundary basins creating yet another level of complexity. Therefore, it is difficult if possible at all to draw general conclusions relating to needs and recommendations on management strategies. Nevertheless, after the International Workshop on Sustainable Management Strategies held in Montevideo, Uruguay (June 2008) it was possible to create a matrix identifying the management strengths and weaknesses of the countries of each basin, as well as proposals and recommendations for improvements. The matrix provides a general and summarized vision of the current management situation in the basins and helps to assimilate, compare, and analyse issues common to all. The proposed management systems include various components of development or improvement towards an integrated management of the water resources. In the concept of integrated management, the different uses of water are interdependent and have to be considered in an integrated system. In the same way, problems in different areas have to be

analysed in a systematic and planned way and the projects that are undertaken have to take into account the hydrological, biological, chemical, physical, and socio-economic consequences.
The countries will advance in the management and shared management of basins if they as much as possible take advantage of the strengths they have and confront their weaknesses. The process is long-term, in which the effort has to be put on modifying the aspects of the water management that are inadequate, preferably in stages, with a reasonable period of time given for each stage. As has been shown in some of the TWINLATIN river basins, an important first step for transboundary rivers is to share collection and use of data, so that a jointly accepted information-base is built.

WP 6 – Emission inventories were carried out to collect data on large and medium sized point sources (industrial, municipal waste water treatment plants). Erosion and sediment delivery to water bodies is considered to be the main contributor of nonpoint source pollution in the TWINLATIN basins (with exception for the Baker river). Together with sediments, nutrients and pesticides can also reach the river system. From this perspective, the spatially and temporally explicit modelling of erosion and sediment delivery is a natural starting point for addressing non-point source pollution Such modelling has been carried out using the WATEM-SEDEM model in most of the TWINLATIN basins (the Cauca, Cuareim, Catamayo-Chira and Cocibolca basins). Diffuse point sources have also been assessed using the SWAT and/or WATEM-SEDEM models in all Latin-American basins as well as in the Norrström basin.

Delivered maps assessing prioritised areas of actions have been produced for all the Latin-American basins and for Norrström. Examples of these prioritised areas are given below. The main **impact** of diffuse pollution in the Catamayo-Chira basin is the sedimentation of the Poechos reservoir. This phenomenon however can only be observed at the reservoir – that means only at one specific point situated at the outlet of the study area. This implies that, no matter what the spatial distribution of pollution pressures is, the impact is always the same.
As far as it concerns soil loss and river pollution, a differentiation of impact however is already realized in this basin. There, the most affected areas / micro basins in terms of sediment production and following river export are identified.

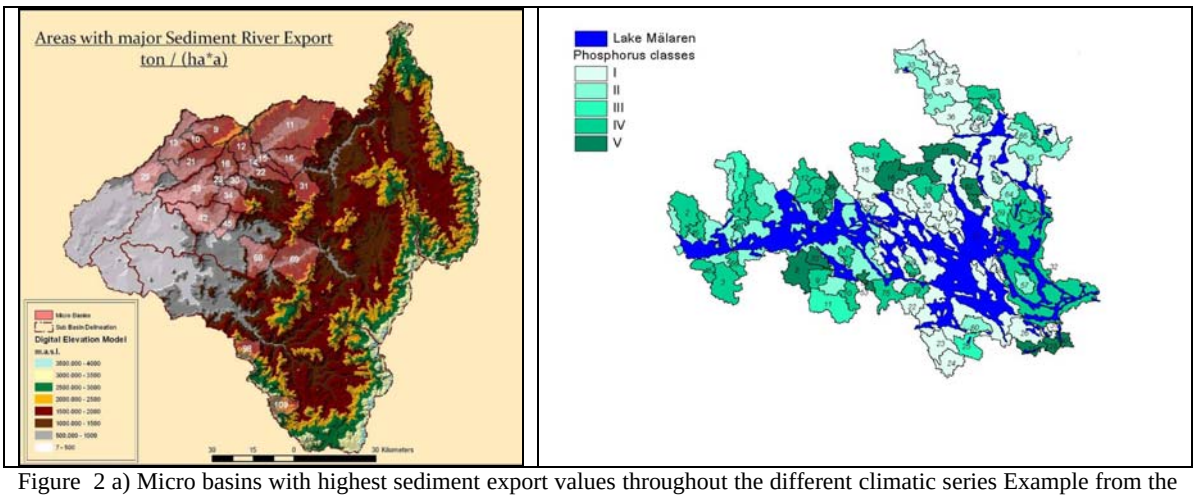

Figure 2 a) Micro basins with highest sediment export values throughout the different climatic series Example from the Catamayo-Chira basin. b) Example from Norrström basin: Area specific losses of Phosphorus kg/ha

At Norrström basin in order to provide maximum benefit of the work in WP6 to the end-users, the resources were concentrated on the tasks relating to improvement of modelling of nutrient transport to Lake Mälaren. Eutrophication of the Baltic Sea and Lake Mälaren poses a serious environmental problem with increased algae blooms and oxygen depleted bottoms. The nutrient loads that the TWINLATIN project resulted in shows that the nutrient loads from the area nearby Lake Mälaren has the same impact as the surrounding watersheds.

The effort in the Cuareim/Quarai basin related to analyse the effect of dams on fish communities should be noted "Analysis of the change in the specific richness of the Cuareim River Basin from 1950-1980 to 2006", being the first study on fish in the basin. From the work done it was concluded that the number of species in the Cuareim River Basin has not diminished since 1950 up to 2006. Not only has the number of species maintained in the principal channel but also the creeks that are in the basin have high fish diversity. The diversity and equitativity indexes also indicate that the basin as a whole is quite similar in these factors.

A considerable part of the progress that has been obtained in the different basins would have been very difficult to achieve without the intensive twinning activities that have taken place. **Twinning** has thus clearly allowed **reaching much further** than what would have been possible otherwise.

WP 7 - A first categorisation scheme was establish in the LA river basins and a first practical classification of the water bodies at the basin scale was carried out. For the Baker river basin a total of 17 river types considered as representative for the Baker River basin were established, of which - after an estimation in function of a pressure analysis - the conclusion was reached that the majority of the different types have segments under a probable reference condition status. The Baker Basin still presents exceptional conditions (in comparison with many other basins in the world) which allowed for an experimental definition of reference conditions.
For the Cuareim/Quarai basin (Uruguayan side), the project activities were oriented to advance the knowledge on **ecological status** of the water bodies in the Cuareim River basin and to contribute with information for **definition of a Monitoring Plan**. The methodology used was inspired by the EU Water Framework Directive, with the necessary adaptations to the characteristics of the basin. Combining three layers of information for the Uruguayan territory: altitude, contributing area and geology; 17 classes were obtained and therefore the river reaches were grouped by expected similar natural characteristics. For each class one reference station should be established. Some of these classes were quite small in area so they should be further analyzed to justify the need of a reference site. From TWINLATIN Working Package 2, the water quality-quantity monitoring was carried out at 4 locations, 3 in the main channel and one on Brazilian territory and thus allows preliminary conclusions as follows:

- The quality of the Cuareim river in general is good.
- Some variables show an increase in the relative concentrations closer to the mouth of the river.
- Some variables show an important association with the flows or volumes of water at the moment of the sampling.

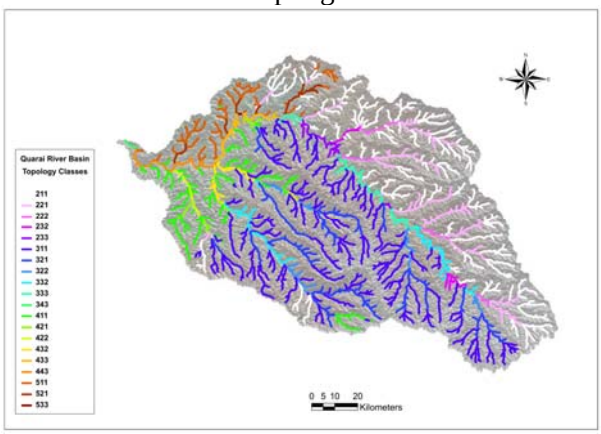

Figure 3 River water body typology for the Cuareim-Quaraí River Basin (20 classes)

The water body typology in the Cuareim-Quaraí River Basin (Brazilian side) was established. Rivers were grouped in 20 typology regions in the basin through 4 hydromorphological parameters. Type-specific reference conditions for each water body type were established using

the best available data. Two classifications of water bodies were performed based on the combined analysis of a series of layers representing different types of human pressures. These two classifications schemes clearly show that the main economic activity developed in the basin, rice production, constitutes the principal human pressure on the ecological status of water bodies.
Currently, almost no field data is available which would allow for a characterization of the different water body ecosystem types in the Cocibolca Lake Basin. In TWINLATIN a first approximation for the "reference land cover conditions" was used to establish "reference" spatial erosion patterns and magnitudes under natural land cover in the basin (forest). These "natural" micro-basin or river reach contributions can then be deducted from the results obtained from the "current land use" erosion & sediment maps, in order to obtain a view of where human-induced sediment delivery is high(est). This would indicate the areas where mitigation/prevention actions may be most effective, and therefore their inclusion in a priority list for action can be considered.

In the Catamayo – Chira basin, a river segment categorisation has been carried out for the first time, based on a GIS analysis. The approach followed the methodology established in the Frame Directive on Water of the EC. 32 water body types were identified for the whole Catamayo – Chira basin, as a basis for establishment of reference conditions and assessment of the ecological quality of the water bodies. Due to logistic limitations, the practical classification was carried out only in the River Quiroz sub-basin. As a result of this preliminary process, fifteen stations were assessed in three biological/ecological sampling campaigns. The results of the sampling campaigns are available and will be the base for future research on ecological status. In the Cauca basin, twenty-three (23) types of water bodies were established through cross referencing of the included variables. This first classification of water bodies is done by combining variables such as the drainage area, altitude and type of soil, according to map overlapping to determine a class in which the typology is identified. According to the above classification, there are 23 types of classifications. By combining data on reference variables and degrees of pressure, the results show that 58% of the water bodies in the pilot Bugalagrande basin show contamination. This is a situation that in general terms, represents the status of the entire Upper Cauca Basin, where agricultural activities and population settlements generate the greatest pressure on water bodies.

WP 8 –The vulnerability of water bodies to environmental changes and external pressures can be assessed by means of expert judgement, monitoring, and the analysis of historical data sets and modelling approximations. The approach followed in the TWINLATIN project builds mainly on the use of the mathematical models developed in WP 3 and WP 6. Future anthropogenic pressure and changes in water demand are forecasted/predicted, and the hydrological, chemical and biological/ecological effects of these changed conditions are estimated using GIS and modelling techniques. Examples of large-scale changes that are analysed are climate change, land use change, changes in agricultural and forestry practices, urbanisation, hydropower development projects etc. Change effects and vulnerability assessments have been made for the mainland South American continent, in addition to those for the TWINLATIN basins, using a grid-based modelling approach (GWAVA) which enables a consistent methodology to be applied across the whole continent.
In the TWINLATIN project, all partners agreed to use a harmonized approach in the context of the analysis of climate change effects. Therefore, in all Latin American basins future scenario projections were created with MAGICC/SCENGEN version 4.1 that then could be used for perturbation of baseline scenarios. The following table summarizes which climate change scenarios were developed, the methods used to create the scenarios, and what methods were used to assess the impact of future climate change scenarios.

Table 2 Future climate change scenarios in TWINLATIN basins

Basin	Climate change scenarios	Method of scenario creation	Method of impact assessment
Baker	Perturbations of time series with change signals for temperature and precipitation	MAGICC/SCENGEN Regional Climate Model	SWAT
Catamayo-Chira	2 climate change scenarios based on A1 and B2 and 4 Global Climate Models	MAGICC/SCENGEN	SWAT
Cauca	Perturbations of time series with change signals for temperature and precipitation	MAGICC/SCENGEN	HBV
Lake Nicaragua	Perturbations of time series with change signals for temperature and precipitation	MAGICC/SCENGEN Regional Climate Model	Analysis of change values, expert judgement
Quaraí/ Cuareim	Hypothetical changes in annual mean precipitation and temperature for sensitivity analysis (precipitation: -20%, -10%, -5%, -1%, +1%, +5%, +10%, +20%; temperature: from -3 °C to +3 °C in steps of 1 °C)	Expert judgement	MGB-IPH
	Monthly changes in temperature and precipitation	MAGICC/SCENGEN	
	Extrapolation of frequency of ENSO events an non-lineal tendency	Analysis time series 1931-2002	Assessment of irrigated/harvested area and net returns
South America	8 Global Climate Models with one SRES scenario A1B, and HADCM3 with three SRES scenarios A1B, A2 and B1, for time horizons 2020, 2050 and 2080.	IPCC website www.ipcc-ddc.org	GWAVA

The methodology that was proposed in WP 8 for assessing land use changes was based on 3 important steps: The identification of historical land use changes within the study area, data collection and geo-database construction, the generation of plausible future land use scenarios, and the modelling of the potential impact of these plausible scenarios on availability & quality of natural resources (e.g. water, soil), as well as the associated societal impacts (*integration of results from WP 8 in activities of for example WP 3,WP 9 and WP 6*).

A vulnerability assessment was also carried out in the LA basins (Vulnerability is defined as the extent to which a natural or social system is susceptible to sustaining damage from for example climate change).

The Description of Work for WP 9 followed closely the methodology recommended in the guide for implementation of the economic analysis of the Water Framework Directive. The tools included in this guiding reference were also the focus of the workshop in April 2007 in Santiago, when work in WP 9 began as well as in the Spanish guide that was elaborated. All river basins have with different ambitions followed this guide and have completed the economic analysis of water uses, the cost-recovery analysis and the baseline scenario. These in turn have served as input for their selection of actions to address the major water problems in the basins. It is mainly here where the focus has differed from that of the Water Framework Directive. A common problem in most of the river basins is principally water quantity rather than water quality. The actions have therefore been chosen in order to address this problem and to find a price for water. Further, even though there are water quality problems which need to be addressed such as in Cocibolca, the information is poor. Proposed actions have for example been connection to municipal services, construction of dams, change of cultivation patterns, improvement of agricultural technology etc. Further in the Baker river basin, the water problem has neither been water quantity nor quality but the possible use of the river basin to produce energy with a large hydropower dam. Here the focus was on estimating the economic value of the loss of landscapes. It has also been interesting to see that in at least two of the river basins there has been a strong involvement of stakeholders also in the economic analyses (while in other basins SI have focussed on e.g. participative modelling, pressure and impact assessment, or management strategies). In for example Cuareim-Quaray various meetings have been held

with stakeholders to receive their views and to make them participate in decisions-making. The participation has been high and experiences positive.

The WP 9 objectives have been fulfilled in most river basins. No river basin developed a full program of cost-efficient actions accompanied by a socio-economic impact analysis. The reasons are mainly problems to find detailed data on costs and effects on each action, and the fact that the problems have been more directed to water quantity. The efforts in WP 9 have been a first attempt to transfer knowledge and to define and agree on a common methodology in the Latin American river basins. The results presented are in general positive. Despite scarce information and different problem approaches the results are a significant achievement which can be extended and used in other river basins.

The efforts in WP 10 were considerably expanded compared to the original plan. The twinning workpackage served all other workpackages. Courses, on the job training, workshops, exchange of experts, etc; were organised within this package, addressing needs identified within the other workpackages. From the project kick-off meeting (October 2005), twinning activities were discussed and already during the first progress review meeting held in Coyhaique meeting (March 2006), the first main training focus was identified. This was the need of setting a common database strategy in almost all the basins.

The ArcHydro database structure was decided as the topic for the first training course activity in the project. This course was held at IPH Brasil, in Porto Alegre – Brasil, in April 2006. From this first activity a number of other twinning activities were carried out.

The legacy of the project will be the use of data, results, methods and participatory approaches by the authority partners and by water management stakeholders in future water management and in follow-up research projects. This legacy has been intensely promoted by the twinning activities.

The activities done were divided into the following topics:

a) Training courses (6 formal courses plus a number of short assignments and direct contact between experts from all basins)
b) International workshops (3, carried out in Chile, Peru and Uruguay)
c) Expert engagement (experts from Latin America involved in LA basins as well as experts from European partners involved in LA basins).
d) Contacts with other projects/initiatives (participation in different workshops in Latin-America and in Europe)
e) Publications (6 scientific publications, a number of papers and dissemination material, as well as training and education material)

A permanent dialogue has been established that will continue after the project. Twinning activities have been a continuous in the project, with active participation of all partners. This permanent dialogue and activities has contributed significantly to fill gaps in knowledge and methods and to implementation of a more integrated water management approach in the LA basins.

TWINLATIN has been well connected with other EU and regional initiatives and has served as an important input to identify problems and needs in non-EU river basins to improve IWRM. Promotion of new twinning programmes/projects between EU and other LA basin organisations has taken place helping to develop and transfer the WFD knowledge and concepts. A number of publications and participation in different forum assured the dissemination of knowledge and findings to other regional initiatives.

Overall project conclusions:

- In spite of divers existing structures for water management in the twinned river basins all partners found the European Water Framework Directive a good framework for development of methods and tools for implementation of integrated water resources management.

- TWINLATIN has by collaboration with the major public stakeholders in each basin and each partner country significantly contributed to the transfer of research results and methods to major stakeholder institutions in the countries of the twinned river basins.
- Advances in research and knowledge have been achieved in several fields, such as improved hydrological modelling and pollution pressure modelling, methods for and results on impact of climate and societal change on water flow and pollution, as well as improved knowledge on the economics of water use and action cost-effectiveness. Throughout the project and with increased intensity in the second half, stakeholders from 'grassroots' to national authorities have been involved in discussions on research methods, results and abatement measures.
- A harmonized approach in the context of the analysis of climate change effects (baseline and scenarios) was developed at LA basins providing the basis for future projections and adaptation analysis. Methods and impact assessment have been transferred and disseminated to the LA basins.
- A matrix identifying the management strengths and weaknesses of the countries of each basin was developed, as well as proposals and recommendations for improvements. The matrix provides a general and summarized vision of the current management situation in the basins and helps to assimilate, compare, and analyse issues common to all. The proposed management systems include various components of development or improvement towards an integrated management of the water resources. As has been shown in some of the TWINLATIN river basins, an important first step for transboundary rivers is to share collection and use of data, so that a jointly accepted information-base is built.
- TWINLATIN has been well connected with other EU and regional initiatives and has served as an important input to identify problems and needs in non-EU river basins to improve IWRM. A number of publications and participation in different forum assured the dissemination of knowledge and findings to other regional initiatives.
- Twinning has significantly raised the competence level of the third country partners, as well as that of stakeholders and end-user water authorities in all countries. In some areas, the European partners have benefited from ambitious development work carried out by third country partners. Language difficulties and the efforts needed for translation and basic technological support have required more resources than anticipated, but the general conclusion of the consortium is that the advances clearly outweigh these difficulties.

Using and disseminating the knowledge

The R&D conducted in the project results in improved modelling tools and knowledge. Knowledge is disseminated through conferences, workshops, media appearances, meetings with end users, research papers and the website. The active participation of local water authorities and other end users assure practical use of the tools and knowledge gained through the project. Some of the tools improved such as GWAVA, SWAT, Watshman-PCRaster, are marketed by partners on a commercial basis, while tools developed by university partners will be publically available.

Contractors involved

IVL Swedish Environmental Research Institute (Co-ordinator), Sweden
CEH-W, Centre for Ecology and Hydrology, Wallingford, UK
KULeuven, Department of Geology-Geography, Katholieke Universiteit, Belgium
EULA, Center for Environmental Sciences, University of Concepcion, Chile
IPH, Instituto de Pesquisas Hidraulicas, Universidade Federal do Rio Grande do Sul, Brazil
DNH, Dirección Nacional de Hidrografía, Uruguay
UNIGECC, Unidad de Gestión de la cuenca binacional del Catamayo-Chira, Peru/Ecuador
CIEMA, Centro de Investigación y Estudios del Medio Ambiente, Universidad de Ingeniería, Nicaragua
CVC, Corporación Autónoma Regional del Valle del Cauca, Cali, Colombia

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