

European Catchment Characterisation and Modelling

**Summary and Conclusions
of the Expert Meeting**

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Catchment Characterisation and Modelling



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Introduction

In the frame of its institutional activities, the Space Applications Institute (SAI) of the Joint Research Centre (JRC) of the European Commission in Ispra (Varese), Italy is working on the development of methods for mapping and characterising catchments throughout Europe. This activity is embedded in the EURO-LANDSCAPE project, dealing with monitoring and modelling rural development and the environment in Europe. The project is scheduled for the period 1999 to 2002.

The Work Package *Catchment Characterisation and Modelling (CCM)* is focussing on a European wide characterisation and classification of catchments according to surface characteristics, land cover dynamics and run-off conditions. Subsequently, run-off, soil erosion and sediment dynamics shall be modelled for selected (representative) catchments in order to assess the risk of land degradation as well as environmental protection needs.

In the frame of this activity the project held an expert meeting on the topic in July 1999. The meeting was attended by 30 experts from different European countries and with varying backgrounds in the related Earth sciences, as well as in statistics, geographical information systems and environmental monitoring and management.

The aim of the meeting was to discuss the state-of-the-art in catchment mapping, characterisation and modelling and to analyse the current and future needs for related information at the national and European level.

The presentations and discussions resulted in a number of conclusions and recommendations for the future activities of the project as well as in a first discussion of the organisational structure and collaborations necessary to implement the work.

This report gives a summary of the presentations and the recommendations resulting from the discussions. It is intended as a summary for the participants and as general information on the work package.

Main Conclusions from the Meeting

The meeting highlighted the widespread need for high quality data on catchment boundaries, river networks, and catchment characteristics over the pan-European area. At the same time, the scientific and technical challenge of the undertaking was clearly recognised. The most important conclusions to be drawn from the meeting may be summarised as follows:

- a) There is an urgent need for a European wide mapping and coding of catchments and river systems. The challenge of this undertaking has been highlighted. Major problems are linked to the availability of reliable data and to the development of robust analysis algorithms. Such a database would strongly support the monitoring activities of the EEA, the implementation of the Commissions forthcoming Water Framework Directive, and the efforts of the water statistics and GISCO sections at EUROSTAT.
- b) The characterisation and classification of the resulting catchments according to physiographic and socio-economic variables is recognised as an important step towards an improved environmental monitoring and a profound and reliable analysis of cause-effect relationships between political actions and landscape processes in the different regions of Europe.
- c) The development of a catchment typology (classification) is seen as a necessary step for extrapolating the results of sophisticated models of landscape and hydrological processes, usually run at the catchment or sub-catchment level. New grounds have to be broken in this direction to the benefit of both the scientific community and the European policy makers.
- d) The development and/or adjustment of relevant process models needs to be supported in order to develop the basis for assessing the impact of politics, societal changes and possible climate changes on the dominant landscape processes and for predicting likely changes in the European landscape.
- e) Following a pragmatic approach, the modelling activities shall start in parallel to the mapping within a few selected catchments. Initially, these catchments should preferably have a long-term history of monitoring and modelling in order to ensure data availability and expertise regarding the pre-dominant landscape processes. They should further be located in different geographical regions of Europe in order to start a comprehensive discussion at the European level. The final selection of catchments to be studied will be based on a more precise evaluation of their representativity as the mapping and classification will progress.
- f) The establishment of a network of experts and institutes is seen as an important pre-requisite for the project. The network should ensure a wide range of expertise and a sound scientific basis for the implementation of the different tasks. The participants in the meeting have, therefore, been asked to consider participating in this network and to prepare proposals concerning potential pilot-catchments and their contributions.
- g) It has been recognised that considerable work in this field has already been performed and that valuable results have been achieved. The collaboration with existing initiatives such as, for example, the FRIEND project, is, therefore, considered of high importance.
- h) The financial support necessary for the successful implementation of the project needs to be ensured.

Foreseen Activities

As a result of the meeting, the following activities could be identified as having high priority for implementation in the coming months:

1. Strengthening of the links with the European Environmental Agency (EEA), with DG XI – Environment, and with Eurostat in order to further define their requirements. This will allow for structuring the project according to existing priorities.
2. Setting-up of a European network of catchments for detailed process studies. This network will at the same time be a network of institutions collaborating in the effort.
3. Identification and acquisition of Digital Elevation Models (DEMs) and other necessary data.
4. Test the use of DEMs at different spatial resolutions for mapping catchments and river networks, keeping in mind the pan-European dimension of the project.
5. Development and test of catchment indicators describing the physical and the socio-economic environment for characterising the mapped catchments.
6. Strengthening of the links to existing projects.

Session 1: Background, Requirements, Goals

Chairman: Sten Folving

Rapporteur: Jürgen Vogt

The session aimed at an overview of current activities for mapping, monitoring and modelling of catchments at a European scale. In addition, the needs of European organisations (e.g. EEA, DGXI, EUROSTAT) have been discussed.

The first three presentations were introducing the EURO-LANDSCAPE project with specific emphasis on the sub-project 'Monitoring Rural Development and the Environment' and the related activity 'Catchment Characterisation and Modelling'. It was highlighted that the development of a pan-European database of catchments, including the catchment boundaries, the drainage network, a set of physiographic and socio-economic characteristics, a catchment typology and a coding system is seen as the basis for the extrapolation of both point measurements and modelling results (hydrology, landscape processes) to larger areas. Key issues are the representativity of measurements and catchments and the evaluation of policy needs and impacts at the European scale.

The following presentations covered a number of on-going activities directly related to the topic of the meeting and covering large areas. A strong collaboration with these projects will be important.

The Catchment Information System (CIS), currently under development by the ARIS unit of the Space Applications Institute (SAI) has been presented as one approach to answer some of the questions related to EU policies. The CIS represents a statistical sample of catchments (currently around 60) distributed over the EU15 territory with specific interest in agro-environmental issues. Catchment size is between 300 and 1500 km². Each sample catchment is linked to a database with information on topography and land use and it is intended to use a sub-sample of this set to answer policy related questions. The CIS does not provide a European wide database of catchment boundaries and characteristics.

The European Watershed - Coastal Zone Pollution Exchange project, under development at the JRC Environment Institute (EI) in collaboration with DG XI was further presented. The project investigates the implications of EU legislation and policy on soil and water quality through the establishment of a network of inland and coastal catchments, representative of different land use and climate conditions in Europe. The network intends to resolve uncertainties in understanding the links between pressures on soil and water qualities resulting from emitted pollutants, their transfer in the soil-water continuum and finally in the coastal waters on the one hand, and the impact of different management decisions at catchment scale on the other hand. This will be achieved by testing guidelines and monitoring and modelling methodologies at selected catchments in Europe, taking advantage of existing national and regional initiatives.

The FRIEND (Flow Regimes from International Experimental and Network Data) project originated from a European initiative to share data and skills for a better understanding of the spatial and temporal variability of hydrological regimes in Europe. Since its beginning in 1985, the initially North European activity has led to the implementation of FRIEND projects in the Mediterranean, Africa, the Himalayas and Hindu Kush, as well as Asia and the Pacific. FRIEND projects in South and Central America, the Caribbean and the Middle East are under development. FRIEND is now part of the International Hydrological programme under the auspices of UNESCO.

A central activity of the FRIEND projects is to create a database of experimental catchments and related measurements at hydro-meteorological stations. The European project has established a database of about 4,500 gauging stations with an average 28 years of daily discharge

measurements. These gauging stations are located in more than 2500 small catchments (typically less than 500 km²) in 26 countries. Besides the hydrographic data, the database includes information on station and catchment characteristics.

The ARIDE project is a sub-project of FRIEND putting emphasis on the use of FRIEND data for the monitoring and analysis of the impact of regional hydrological drought conditions in Europe.

The final two presentations discussed the status of and procedures for data collection related to inland waters by the EEA and by Eurostat-GISCO. The presentations highlighted the lack of a pan-European catchment database and the difficulties in implementing a coherent and representative reporting system on the quality and quantity of inland waters (rivers, lakes, aquifers) throughout the area of interest of the EEA. The EEA has the political mandate to produce objective, reliable and comparable information on the state of the European Environment. For Europe's inland waters this relates to information on the quantity and quality (status and trend) of water resources in rivers, lakes and aquifers and its links to pressures on the environment (cause-effect relationships). In order to retrieve such information, the European Topic Centre on Inland Waters (ETC/IW) has designed an information and monitoring network for the EEA. This network, called EUROWATERNET¹ is firmly based on national monitoring networks with specific emphasis on the needs of a European monitoring system. It is further designed to be fully compatible with the needs of the forthcoming EU Water Framework Directive.

The information retrieved through EUROWATERNET will, however, be based on a statistical sample. In order to evaluate the representativity of this sample and in order to get a comprehensive picture of the spatial variability of the conditions, a comprehensive database of European catchments and rivers and their main characteristics is considered indispensable. A first step in this direction was the development of the so-called ERICA² database. This database, which presents the 1000 largest catchments of the EU at a nominal scale of 1:1,000,000, has been developed by the Institute of Hydrology (Wallingford, UK) together with the Danish National Environmental Institute (NERI) and the University of Freiburg, Germany for the EEA. Unfortunately, ERICA does not cover the full area of interest and is not freely available in all its parts since it is based on Bartholomew's river network database. A contemporary pilot project to test the possibilities for the development of a European wide catchment and river database at a nominal scale of 1:250,000 has underlined the difficulties to be expected with its implementation.

Albeit the expected difficulties it became clear that the creation of a comprehensive and freely available database at a nominal scale of 1:250,000 is seen as the necessary way forward to fulfil EEA's political mandate to provide consistent, reliable and up-to-date information on the status and trend of Europe's inland water resources.

Eurostat-GISCO currently includes the CORINE catchment data set with nominal scales of 1:3,000,000 and 1:10,000,000. ERICA has not yet been included since quality testing according to GISCO standards is not completed. Any new database should comply with GISCO specifications and quality standards in order to ensure a smooth integration with other data sets and easy distribution to the interested scientific community and the public. GISCO underlines the need for a comprehensive database not only for the needs of the EEA, but also for the needs of Eurostat's Water Statistics section.

¹ EEA (1998): EUROWATERNET. The European Environmental Agency's Monitoring and Information Network for Inland Water Resources. Technical Guidelines for Implementation.- EEA Technical Report No. 7, June 1998, Copenhagen, 47 pp.

EEA (1996): European Freshwater Monitoring Network Design.- Topic Report No. 10 - Inland Waters. Copenhagen, 129 pp.

² ERICA: European Rivers and Catchments

Session 2: Catchment Mapping and Monitoring

Chairman: Des Walling

Rapporteur: Sten Folving, Pamela Kennedy

The main aim of this session was to review some of the past and on-going work dealing with the issues of mapping and monitoring catchments in Europe.

The first speaker illustrated the results of a method to automatically delineate catchments using a DEM (Digital Elevation Model), and the consequences of utilizing different resolutions. Catchment boundaries derived from the global GTOPO30 DEM (approx. 1 km grid cell size) and boundaries derived from more detailed DEMs (250m and 60m grid cell size) obtained for Sicily were compared. It was found that the total number of sub-catchments identified using the 60m and 250m resolution was very similar, with a difference in surface area of less than 2%. Differences between the coarse (1 km) and fine resolution DEMs were found to be reduced if a 15 km² threshold value was enforced as the minimum drainage area or so-called 'reference cell'. Major problems are related to the identification of the river network and the subsequent ordering of the channels.

The second presentation dealt with the issue of Headwater Control and the factors that should be considered and even promoted in order to lead to a more holistic management of headwaters for sustainable development of these sensitive and threatened areas. The speaker described the aims and objectives of the IAHC (International Association of Headwater Control) which was founded in 1997.

The third and fourth presentations described in more detail the specific characteristics of rivers and drainage areas in Denmark and Italy, respectively. In the former case the speaker gave a detailed description of the fluvial dynamics and sediment transport in rivers leading to the Danish Wadden Sea. Denudation rates, sediment characteristics, and patterns of deposition were detailed following data collection in the field. In the case of Italy, river basins in Tuscany, *i.e.* the Arno, were described in terms of the changes taking place over a hundred years or more. Emphasis was placed in studying land cover changes, and in particular, urbanization and canalization and the impact such developments have on a river's flow regime and sediment transport. Historical archives of statistical data and photographs were used in an attempt to follow the temporal development and changes which have taken place in the rivers of Tuscany over the past 150 years.

The following presentation gave an overview of some of the work which has been carried out at the SAI in the field of characterizing catchments at the regional scale (spatial resolution 1 to 3 km) for the purpose of monitoring the incidence and severity of droughts and the growth dynamics of vegetation. The use of satellite imagery was illustrated as a source of information for characterizing land cover and vegetation growth dynamics. The benefits of utilizing satellite data and GIS techniques to provide a spatial perspective of the condition of the vegetation cover over time were demonstrated. The possibilities to link remote sensing data, meteorological data and data on altitude and land cover in an energy budget model for deriving a spatially resolved picture of the energy and mass fluxes at the surface has been demonstrated. Important parameters to be retrieved in a hydrological perspective are the latent heat flux, the daily evapotranspiration rate and the evaporative fraction. The advantages and limitations of this approach, such as the need to interpolate point-source data (e.g. meteorological data) to a grid, have been discussed in detail.

The final presentation in this session was dedicated to modelling and predicting snowmelt runoff in Alpine catchments. The use of satellite data was again demonstrated for providing hydrological-related information and surface characteristics in a spatially distributed form at the scale of a single catchment (spatial resolution 30 meters). Such information is traditionally derived from point measurements or completely lacking due to the inaccessibility of such mountainous areas. The

major limitations of such an approach relate to the spatial and temporal scale of the data and to the problems of shadowing and the need for adequate radiometric and geometric corrections of the satellite data.

The most salient points to come out of the discussion of the issues presented in session 2 are as follows:

1. Definite and positive support was voiced in favour of going ahead with the mapping and characterisation of catchments at the level of the European continent. Two very clear justifications were:

a) From the EEA. This would enhance the use of the data collected through EUROWATERNET. In practical terms, the data on water quantity and quality collected at gauging stations throughout the continent, could be positioned in the wider geographical and hydrological context, allowing for an in-depth analysis of cause-effect relationships between water quantity and quality on the one hand and land surface processes and socio-economic processes on the other hand.

The development of a classification (typology) of European catchments and rivers was further deemed necessary for the assessment and monitoring of biodiversity and environmental quality in general.

b) From Eurostat-GISCO. Such a division of Europe would enhance the utility of statistical data, by being able to link them with environmentally relevant geographical units. It would give an added value to the water statistics as elaborated in the water statistics section of Eurostat.

Session 3: Catchment Characterisation and Modelling

Chairman: Jesper Bartholdy

Rapporteur: Maria-Luisa Paracchini

The session aimed at providing examples of the application of models of soil erosion, sediment dynamics and wetland management at the catchment scale. These models describe the most significant landscape processes occurring in drainage basins and highlight the principal elements characterising catchments.

The first speaker illustrated the necessity of retrieving information on erosion and sediment yield, as these represent key processes in the drainage basin and, therefore, are an important requirement for catchment characterisation. Not only erosion and sediment yield should be modelled, but also the sediment budget in terms of interaction between sources, sinks and outputs and the overall sediment delivery. Ecological effects associated with habitat degradation should be taken into consideration. It was stressed that scale has a strong influence on sediment budget: in small catchments the efficiency of sediment delivery from the slopes to the channel system is high, while in large catchments conveyance losses associated with the transfer of sediments through the channel system are predominant.

The second presentation described the MODEM project. The principal objective of this project is to define and demonstrate a pre-operational remote sensing based desertification monitoring system. Regional ecological and physical modelling is integrated with information derived from operational Earth Observation and meteorological satellites, in order to assess and monitor indicators of sensitivity to desertification in the Mediterranean basin. A Regional Indicator Index is calculated from a physically based model, which combines climate, soil and erosion processes with actual vegetation cover derived from AVHRR images.

In the third presentation a comparison between the USLE and EPIC models as applied in a Hungarian catchment was presented. The results show that there is a good spatial coincidence in soil loss values provided by these two models and a good correlation with the soil erosion risk map. The absolute values, however, are generally higher in EPIC results. The possibility of obtaining monthly averages from the EPIC model was also investigated.

In order to enhance scale-related issues, the fourth speaker presented a study carried out on three nested basins in Northern Spain. In particular the relationship between the main hydrological fluxes, as a quantitative evaluation of water resources, and the relationship between discharge, sediment transport and sediment yield were analysed. Preliminary results underline the importance of undisturbed forest soils to ensure the entrance of water in the system and the need for controlling the non-point sediment sources through forest management practices.

The fifth presentation dealt with the identification of sediment sources and storage. The work was carried out in two basins in the Carpathians and showed the importance of the dense network of unpaved roads in this region as both source and pathway for rapid sediment delivery to the stream channels. Radiocaesium measurements indicate that a substantial proportion of the eroded soil is re-deposited on the agricultural terraces and is not transported downslope.

The sixth speaker showed an example of historical river responses to land use changes, in terms of variations in sediment budget and habitat degradation. The analysed river is the Arno in Tuscany, for which archeological and historical documents show how changes in land use policy affect the hydrological behaviour of the river system.

The seventh presentation introduced the SHYLOC project, in which new integrated technologies have been developed in order to improve hydrological predictions in wetland areas. This has been

achieved by coupling the hydrological model MIKE SHE with the hydraulic model MIKE11, and integrating in the process the analysis of Landsat TM images for the identification of ditch networks.

Finally, the Environmental Information System (SINAMBA) of the region of Andalucia, southern Spain, has been presented and the environmental impact of the 1998 Aznalcollar mine accident for the Guadiamar basin has been discussed.

From the presentations and discussions the following points emerged for consideration in catchment characterisation and modelling:

- a) There is a need to characterise sediments and their sources.
- b) There is a need to calculate sediment budgets, i.e. the amount of sediments transported and deposited.
- c) Scale determines which processes are predominant.
- d) Radionuclide measurements may identify sediment sources and deposition, but provide point measures, which are not indicated for distributed studies.
- e) In order to understand changes in sediment yield over time it is extremely important to analyse socio-economic aspects. A change in management policies often corresponds to land use changes and this leads to changes in sediment yield. Hydraulic works in the river bed may also cause an alteration in the erosion/deposition regime along the river banks.
- f) Alterations in erosion/deposition regimes along the coasts reflect land use changes in the catchments (in Italy this is true for up to 80% of coastal catchments).
- g) There is a general difficulty in finding and retrieving data on erosion and sediment dynamics. The risk of duplicating databases is high. Data accessibility remains a problem.
- h) Validation of soil erosion models at the catchment scale remains an unsolved problem.

Session 4: Planning and Recommendations

Chairman: *Jürgen Vogt*

A: Working Group on Catchment Mapping

Report: *J. Vogt*

Objectives and Needs:

The discussions of the working group highlighted the need for a European database of catchments (boundaries, characteristics, typology). The following organisations were identified as having a particular interest in such a project:

1. EEA: EEA is in need of a database of catchment boundaries and characteristics, covering the pan-European area at a nominal resolution of 1:250,000. A nominal resolution of 1:1,000,000 is acceptable as an interim solution, in case the higher resolution project proves infeasible in the mid-term. The major use for such a database is to link the point measurements (quality and quantity) collected in the frame of the EIONET – WATERBASE to the catchment area and its characteristics and for implementing the EUROWATERNET.
2. DG XI (Environment) has a clear need for the implementation and control of the forthcoming Water Framework Directive. The calculation of proxy pressure indicators on a catchment basis and the analysis of the relation between human activities and water quality are seen as major applications.
3. EUROSTAT is interested to include such information into the GISCO database. The Water Statistics Section could further use these data for the development/improvement of significant water statistics (e.g. for the transfer of information from the administrative level to the catchment level).
4. Non-Governmental Organisations (NGOs) and Organisations in charge of the establishment and control of Marine Conventions have been mentioned as potential customers.
5. Finally, the EURO-LANDSCAPE project and the participants to the meeting have a clear interest in such data in order to be able to evaluate the 'representativity' of catchments to be selected for detailed modelling of hydrological and landscape processes. Only through the characterisation of catchments and the development of a catchment typology should it be possible to extrapolate the modelling results over larger areas.

Data Availability:

Currently no adequate database on catchments covering the pan-European area is existing. The best available is the so-called ERICA database, giving the largest catchments (about 1000) over Europe at a nominal scale of 1:1,000,000. The Institute of Hydrology (Wallingford, UK) developed ERICA under contract for the EEA. Mapped catchments do not cover the whole area (e.g. all coastal areas are missing) and not all information is freely available. While the catchment boundaries are EEA property, the river network is property of Bartholomew and copyright protected.

To create a new database of catchment boundaries and for the derivation of physiographic characteristics, the following data are currently available:

1. US Geological Survey (USGS) GTOPO 30 DEM, with an approximate grid-cell size of 1 km.
2. US Defence Mapping Agency (DMA) – National Imagery and Mapping Agency (NIMA) DEM, with a grid cell size of 90 meter. This DEM has been developed for military purposes

and as such is not freely available. Whether it could be made available for the purposes of this project needs further investigation.

3. In October 1999 NASA, NIMA, ASI and DLR³ will fly the X-SAR/SRTM space shuttle mission. During eleven days an X-band and a C-band interferometer will cover the globe from 58° South to 60° North. From these data a DEM of 30 m grid cell size and an altitude accuracy of about 6 to 10 meters will be derived for all landmasses covered. Processing time for the full data set is estimated to about two years and will be done by DLR. The advantages of this DEM will be its spatial extent, high spatial resolution, and homogeneity over the full area.
4. National DEMs with varying spatial resolution are existing for the different member states (e.g. Italy at 250 m, France at 250 m, Germany at 30 m). Data availability, copyrights, prices, projections, methodology of derivation, accuracy, etc., are – of course – widely varying and would need to be checked.

It was noted - but also disputed in the plenary discussion - that the project should not aim at the analysis of national data sets, due to problems of incompatibility and copyright. The use of a pan-European DEM for the derivation of a consistent data set was highly recommended.

Deliverables:

The deliverables for the mapping activity would be a consistent map of catchment boundaries, covering the whole pan-European area. This data should comply with GISCO quality standards and should be freely available for distribution.

The scale to aim at in the long term is 1:250,000. However, a feasibility study conducted in the frame of the ERICA contract concluded that for such an undertaking a detailed map of the river network is needed. Currently the only one available is the Bartholomew's map, which is copyright protected. The creation of such a database is considered a major undertaking.

In addition to the boundaries of the catchments, coding of the catchments is needed. Such a coding system will strongly raise the value of the database, since it will enable use of the data for analysis purposes rather than for mapping and display purposes only.

If an undertaking at the 1:250,000 scale would seem infeasible for the moment, the completion and further development of the 1:1,000,000 ERICA database has been suggested as a first step.

Actions:

A number of activities could be identified in order to clarify the situation:

1. Identification of available DEMs and hydrographic network data covering the pan-European area and investigating the conditions of use.
2. Test and evaluation of methodologies for the derivation of catchment boundaries at scales ranging from 1:250,000 to 1:1,000,000.
3. Verification of the possibilities for funding from DG III (Industry), DG VI (Agriculture), DG XI (Environment), DG XII (Research).

³ NASA: US National Aeronautics and Space Administration
 NIMA: US National Imagery and Mapping Administration
 ASI: Italian Space Agency
 DLR: German Aerospace Research Centre

B: Working Group on Catchment Characterisation

Report: D. Walling

Objectives:

The discussions of the Working Group confirmed that the emphasis of the Project under discussion should be on characterising and modelling the *landscape* and *landscape processes*. As such the approach would need to extend beyond more traditional hydrological characterisation and modelling. Within this framework, catchment characterisation would serve three key purposes, providing the basis for:

- 1) Comprehensive catchment classification and thus the production of typologies and the selection of a set of 'representative' catchments.
- 2) Aggregation of catchments to identify 'homogeneous' zones or groups of catchment units at the pan-European scale.
- 3) Extrapolation of model results from representative catchments to the entire pan-European region.

Approach:

As a guide, it was suggested that attention should focus on a catchment size of ca. 500 km². Catchments of this size should afford an effective basis for representing the key features of the landscape and for developing effective models of landscape processes. Although the experimental catchments traditionally studied by hydrologists were generally an order of magnitude smaller, it was agreed that larger units would afford a more effective basis for landscape description, with an emphasis on representative features and response, rather than local conditions and behaviour. However, it was emphasised that this size should not be considered as fixed. It would need to be reviewed in the light of experience and there may be a need to vary the scale of approach to meet different objectives.

Catchment characterisation should be based on a set of fundamental multipurpose parameters capable of representing both the diversity and the key features of the pan-European landscape. A primary objective should be the standardisation and harmonisation of procedures, in order to establish a methodology capable of objective application at the pan-European scale.

In discussing the selection of key parameters, it was agreed that this exercise would require significant effort aimed at rigorous testing of their capacity for representing and discriminating major landscape types. Preliminary consideration suggested that a comprehensive set of parameters would need to include both *physical* and *socio-economic* descriptors. These descriptors were likely to include the following:

Physical Descriptors

Where possible these would be derived from existing data-bases and remote sensing and would include:

- a) Topography (based on DEMs).
- b) Drainage Network and River Channel characteristics.
- c) Geology (with emphasis on lithology rather than traditional geological classification according to age).
- d) Land Cover (to include both cover types and patterns and land use practices).

- e) Climate (key indices).
- f) Hydrological Response (key indices).
- g) Soil Properties (with emphasis on physical and chemical characteristics rather than genesis).

Socio-Economic Descriptors

- a) Population density
- b) Population distribution
- c) Water Use and Waste Disposal

Actions:

It was recognised that any attempt to develop a comprehensive scheme for catchment characterisation applicable at the pan-European scale and capable of underpinning the aims of the project would need to break new ground and could not be based on existing information and procedures. A number of actions required to initiate work on catchment characterisation were identified, viz.

- 1) Further work is required to identify and test a set of key catchment descriptors, which are capable of providing an effective basis for comprehensive catchment characterisation.
- 2) Existing data sets capable of being used for deriving catchment characteristics should be identified and evaluated.
- 3) New data sets necessary to derive key descriptors will require development. Emphasis should be placed on standardisation of data availability at the pan-European scale.
- 4) Research on optimum methods for deriving key descriptors from DEMs and remote sensing sources etc. (e.g. topographic indices, drainage network properties and channel characteristics) will be required.
- 5) There is a need to involve additional perspectives (e.g. eco-hydrologists) in order to ensure that the goal of developing procedures for comprehensive landscape representation and description is achieved.

C: Working Group on Catchment Modelling

Report: J. Bartholdy

Objectives:

During the initial discussions it was decided to restrict the relatively wide-ranging task of the working group by concentrating on pilot studies in selected drainage areas, meant to serve as models for the more wide spread characterisation of catchments in the pan-European area. The purposes of these pilot studies are:

- 1) To give a comprehensive characterisation of these drainage areas as test and development cases for the characterisation of catchments throughout the pan-European area.
- 2) To link GIS-based analysis to field based research as a basis for analysing the interactions between key parameters such as landscape, soil types, river regimes and land use as well as for analysing river responses to landscape changes within the catchment.
- 3) To start building-up of a detailed database related to long-term trends in landscape, hydrology and land use interactions in representative drainage areas.

Approach:

Following the results of the “Catchment Characterisation Group” the size of the selected catchment areas should be of the order of 500 km². They should be representative for larger areas and preferably have been studied for longer periods. As a consequence, time series of key parameters such as run-off, precipitation, and sediment transport data will be available in some form and can provide a head start for the pilot studies.

It is important that the selected drainage areas are well described in terms of digital elevation models, land cover information, soil types, geology, etc.

At least some of the pilot studies should be carried out in drainage areas where decisions made by planners and/or changes in primary conditions (e.g. climate) have created visible changes of some magnitude in historical time. This will enhance the possibilities of illustrating the need for knowledge about the often delicate balances controlling the appearance of the present day landscape.

Actions:

The following actions were deemed necessary in order to start the pilot studies:

- 1) Meeting participants will suggest catchments suitable for the pilot studies to SAI.
- 2) Five to ten representative European catchments, fulfilling the conditions mentioned above, shall be selected as pilot areas.
- 3) A meeting should be organised in order:
 - a) to discuss possibilities for funding of pilot studies;
 - b) to discuss the co-ordination of future actions and the creation of a suitable network.

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A 2: Meeting Programme

Session 1: Background, Requirements, Goals

Chairman: Sten Folving, Rapporteur: Jürgen Vogt

1. Registration of participants
2. Opening of the meeting (*J. Mégier*)
3. The EURO-LANDSCAPE project (*S. Folving*)
4. RDE – Monitoring Rural Development and the Environment (*P. Kennedy*)
5. European Catchment Characterisation and Modelling – Goals and Objectives (*J. Vogt*)
6. The Catchment Information System (CIS) (*R. Hiederer*)
7. A European Watershed-Coastal Zone Network for testing implications of EU directives (*G. Bidoglio, N. Murray*)
8. The FRIEND and ARIDE projects (*G. Rees, S. Demuth*)
9. Activities and interests of the EEA and DG XI (*N. Thyssen*)
10. Catchment data sets in Eurostat – GISCO (*T. Carlquist*)
11. Discussion
12. Definition of requirements and goals in a European perspective (*All Participants*)

Session 2: Catchment Mapping and Monitoring

Chairman: Des Walling, Rapporteurs: Sten Folving, Pamela Kennedy

1. Mapping European headwaters (*M.-L. Paracchini, S. Folving F. Bertolo*)
2. The ‘Headwater Control’ Movement: Foundation and Philosophy (*M. Haigh, J. Krecek*)
3. Introduction to the drainage areas leading to the Danish Wadden Sea (*J. Bartholdy*)
4. Introduction to the rivers and catchment types of Italy (*P. Billi*)
5. Remote sensing in catchment characterisation and modelling (*J. Vogt, S. Niemeyer*)
6. Snowmelt runoff and energy balance models for alpine catchments (*P. A. Brivio, R. Colombo*)
7. Discussion

Session 3: Catchment Characterisation and Modelling

Chairman: Jesper Bartholdy, Rapporteur: Maria-Luisa Paracchini

1. Characterising erosion and sediment yield (*D. Walling*)
2. Modelling of regional erosion risk at national to continental scale (*S. Sommer, M. Kirkby*)
3. Soil erosion modelling and monitoring using GIS for a Hungarian catchment (*T. Huszár*)

4. Monitoring water and sediment dynamics in catchments of the Pre-Pyrenees (*R. Batalla*)
5. The use of fallout radionuclides and classical monitoring techniques in investigations of sediment transfer through the fluvial system in the Polish Flysch Carpathians (*W. Froehlich*)
6. Land use change and river response in Tuscany (*P. Billi, J. Bartholdy*)
7. New integrated technologies for wetland management (*D. Al-Khudhairi*)
8. The Environmental Information System of Andalucia (SINAMBA) and the Guadiamar river restoration project (*E. M. Vázquez Sanchez*)
9. Discussion

Session 4: Planning of Future Activities

Chairman: Jürgen Vogt

Working groups on:

- A: Catchment Mapping (*Chair: J. Vogt*)
- B: Catchment Characterisation (*Chair: D. Walling*)
- C: Catchment Modelling (*Chair: J. Bartholdy*)

Presentation of the working group results and discussion