European Topic Centre on Inland Waters

HUMAN INTERVENTIONS IN THE HYDROLOGICAL CYCLE

By
A. Scheidleder, G. Winkler, J. Grath and W. R. Vogel

October 1996

This report was prepared under the supervision of N. Thyssen, Project Managei,
European Environment Agency

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EXECUTIVE SUMMARY

Project Objectives

This report describes a scoping study to set the terms of reference for a later study which will quantify and compare human interventions across all European Environment Agency (EEA) Member States. As such there is a need to define precisely human interventions and agree a methodology for quantifying their effects on water resources, water and ecological quality of the water and riparian areas. There will be a need to co-operate with other Topic Centres such as those on Nature and Soils. The comparison of the impacts and effects at a European level will also bave to consider regionalisation, for example by biogeographic zone and/or hydrological regimes. At this stage comparison by biogeographic region appears to be inappropriate and comparison by hydrological (flow) regimes will have to be considered.

Human interventions can have profound effects on water resources, water quality and aquatic and riparian ecology. There is a need to quantify both their extent and importance, and to quantify the nature and significance of the effects they have. The inter-relationship between intervention and effect must be understood before proper planning and control can be undertaken and so that the benefits of the intervention can be properly balanced and assessed against any environmental effect. The importance of human interventions in terms of effects on ecological quality has been recognised by policy makers and are included in Article 4 of the proposed European Commission's Directive on Ecological Quality of Water (COM(93) 680). Under this proposa1 Member States will be required to assess the effects of 'any other anthropogenic factors which impair or might impair the ecological quality of surface waters'.

The Technical Work Programme for the 1995 Subvention of the Agency's Topic Centre on Inland Waters (ETC/IW) gives the objective of this work as ***"to** determine **on a** pan-European scale **the** significance **and key issues** from human **interventions in the hydrological cycle".***

The report and the selection of the most significant interventions in the hydrological cycle is based on a consultation of experts at AWW (Austria), INAG (Portugal), IOW (France), NERI (Denmark) and NIVA (Norway). Therefore some aspects concerning other countries or regions may have been missed at this stage and will become evident in the further process.

Biogeographic Regions

The effects of human interventions in the hydrological cycle can have significant ecological effects. Considering this, a region-based process of prioritising the human interventions in the hydrological cycle was applied. For this scoping study, therefore, it was decided to use and appraise the appropriateness of the Biogeographic Regions used by the European Topic Centre on Nature Conservation (ETC/NC) for some aspects of its

workprogramme. The 6 Biogeographic Regions (Boreal, Atlantic, Continental, Alpine, Mediterranean, Macronesian) have been determined by the European Commission (EC) for the purpose of the Natura 2000 process required for the EC Habitats Directive. The definition of the 6 Biogeographic Regions was considered by the Commission to be adequate for political purposes though ecologically it is not precise enough. A more accurate map of ecological regions at a pan-European level is being prepared by the ETC/NC and contains some 30 classes. As an alternative to Biogeographic Regions the use of hydrological flow regimes (such as used by the FRIEND programme) might be more appropriate; this will be considered in the next phase of this study.

Selection of Human Interventions

In order to detect the most significant human interventions in the hydrological cycle, the ETC/IW partners identified a maximum of six aspects from a list of possible human interventions, and at least one aspect from each main category, for each biogeographic region.

The main categories for human interventions were:

A. River, lake and estuary regulation

B. Water abstraction

C. Activities in the catchment

The selection conforms to the significance of the physical intervention and the importance of its effects. The contributors gave a short description and an explanation of the intervention, the extent, the benefits and both positive and negative effects. Examples of the interventions and their effects are also included in the contributions.

It should be noted that the following selection of the most significant human interventions in the hydrological cycle is solely for the contributing countries and their specific experiences, and cannot be extrapolated to the whole Europe without further work. These contributions also do not represent official statements from those countries but are the opinions of experts.

Main Interventions in the Hydrological Cycle

A number of significant human interventions have been highlighted in the report. These are:

- Damming for generating hydroelectricity, especially in the Alpine and Continental regions and in Norway (Scandinavia), appears to be the most significant human intervention within the river, lake and estuary regulation category.
- Groundwater abstraction for public water supply and irrigation purposes seems to be the most significant intervention involving water abstraction and is most obvious in the Atlantic, Continental and Mediterranean regions.
- Land sealing by urbanisation and land drainage for cultivation occur in each of the proposed regions and, where it occurs, seem to be most important activities in the catchment.

- Damming for public water supply and irrigation, river channelisation for flood control and drainage purposes, and the intensification of agriculture obviously play a major role in the hydrological cycle.

Bearing in mind that the selection of the interventions is restricted to the contributing countries, it can be seen that some human interventions occur in all biogeographic regions. For example, in this report the Norwegian Atlantic region is closely related to the Alpine region:

- Land sealing from urbanisation and land drainage for cultivation occurs in all biogeographic regions.
- Damming for public water supply and for irrigation pur-poses seems to be a typical intervention in the Atlantic and Mediterranean regions.
- A number of human interventions occur both in the Atlantic and the Continental regions and seem to be significant just in these regions:
  - Damming for flood control and fish farming;
  - Dredging of river channels to drain land;
  - Surface water abstraction for fish farming;
  - Wet cuts.
- River channelisation for drainage and intensive agriculture occur in the Atlantic and the Continental regions.
- Groundwater abstractions for public water supply and irrigation put-poses are the main significant interventions in, the Atlantic, Continental and Mediterranean regions.
- Dredging of river channels for mining river bed grave1 and surface water abstractions for hydropower and for interbasin water transfer seem to be typical major interventions in the Alpine region and Norway.

Conclusions

Major human interventions with significant ecological impact have been identified in all participating countries. The most significant human interventions in the hydrological cycle have been made over the last decades. Today the negative effects of these interventions are recognised and analysed, and restoration activities are initiated. The perception of the importance of an intervention changes over time, as the understanding of the aquatic environment evolves.

Key figures and statistics concerning freshwater resources, freshwater abstractions, and major uses by countries are not readily comparable because of the different methods of assessment and calculation in each country. However, comparable data characterising the hydrological cycle, the water balance and water demand are necessary to quantify and judge the human interventions identified in this report, and on the basis of figures which characterise the extent of the impacts (quantity measures), to identify key issues relevant for the EEA.

One of the main difficulties in determining the significance of human interventions in the hydrological cycle on a pan-European scale appears to be the lack of appropriate criteria or regional scale for comparison. To that end the use of the regionalisation of the continent by the Biogeographic Regions used for the Natura 2000 process would be inappropriate. From the hydrological standpoint this division of Europe does not seem to be optimal due to the fact that hydrological characteristics vary strongly within a biogeographic region. Interventions in the hydrological cycle are not mainly based on the biogeographic regions itself but rather caused by human pressure (population density etc.) and cultural development. Further, distance between supply and demand, the pressure and the intervention, becomes relevant (e.g. upstream flood control of cities, distant hydropower generation etc.).

Recommendations

1. There is a need to increase the comparability of data with regard to human interventions and to extend data collection to all EEA countries.

2. The regionalisation of the continent should, if required for the comparison of human interventions, be based on hydrological characteristics and/or on human pressures and demand.

3. The investigation on significant human interventions in the hydrological cycle should be extended to all EEA countries to give a representative overview of the situation across Europe. The reasons for an intervention should, in particular, be outlined in a detailed way, which may help in defining the most appropriate comparative regions. The importance of interventions nationally, regionally and across Europe should then be able to be assessed.

4. Single interventions should also be investigated separately with more detailed assessments on the impacts on water quality.

5. At this stage of the Project the different human activities have not been fully quantified at a national or European level. For example, there appears to be no real information on the extent/intensity of different activities affecting the hydrological cycle. Information such as on the number of dams in a Member State and the catchment area affected, or the approximate length/% of river channelised or under flow regulation might be feasible to obtain in the near future. Indeed work undertaken by the ETC/IW on developing a reservoirs database has begun to quantify the number of dams, reservoirs and lakes across the EEA area. The next phase of this study must address these issues and should suggest a list of data/information which each Member State could supply in the medium term (next two or three years).

6. It is recommended that the methodology and definitions used in this scoping study are further refined and developed in light of the experience obtained. Information gathering should then be extended to other EEA Member States. It should be noted that the work on human interventions affecting groundwater quality and quantity will be addressed in the Groundwater Quality and Quantity Monograph to be produced by the ETC/IW in 1997 under the 1996 subvention.

1. INTRODUCTION

1.1 Background

Water regulates life and as such is of fundamental importance to human, other animal and plant life. Because of the interaction between atmosphere, lithosphere, hydrosphere and biosphere and the consistency of the global water cycle, every change or modification in one of these spheres will consequently lead to a modification of the water cycle and water balance.

In this context humankind plays a special role. As part of the biosphere it massively influences other spheres, especially through water consumption influencing the global hydrosphere. Because of the complex physical and chemical properties of water it does not only serve humans as a source. of food but also as a means of production in agriculture, aquaculture, forestry, industry, energy and as a means of transport.

Artificial alterations to the natural cycle of water has produced massive changes in agricultural landscape and in aquatic, riparian, wetland and other floodplain habitats. These interventions have had both positive and negative impacts on the problems that they were intended to solve. Some of these activities have greatly constrained the degree of interactions between the river channel and the associated floodplain with catastrophic effects on biodiversity.

1.2 Tasks

According to the European Environment Agency's Topic Centre of Inland Waters' (ETC/IW) Technical Work Programme for the 1995 Subvention (Feb. 1996), the main task is to determine, on a pan-European scale, the significance of and key issues arising from human interventions in the hydrological cycle.

The first step of defining a strategy on this issue will be the collation of readily available information on past and on-going activities relating 'to such physical impacts on the hydrological cycle throughout some countries in the EEA area. The basis of the information is the knowledge and experience of the ETC-IW partners. Contributors to the project (AWW-Austria, INAG-Portugal, IOW-France, NERI-Denmark and NIVA-Norway) have reported on the situation in their own countries and from other countries if information is available.

1.3 Structure of the Report

This report comprises four main parts and two Appendices:

Part 1 describes the background, tasks and investigation methods of the project. Hydrological data from different sources are also compared.

Part 2 deals with the Biogeographic Regions defined by the European Commission for the Natura 2000 process and the country-specific descriptions and adaptations on the biogeographic map.

Part 3 (sections 4 (0 6) gives a brief overview of the main human interventions in the hydrological cycle selected by the contributing partners.

Part 4 (sections 7 and 8) gives the main conclusions from this scoping study ənd makes recommendations on how the study should proceed in the next pbəsɐ during the 1996 subvention period.

Appendix A contains a list of possible human interventions in the hydrological cycle.

Appendix B presents the detailed description of the selected ʎunɯn interventions by the contributing partners.

1.4 Investigation Method

AWW provided a draft list of possible human interventions in the hydrological cycle. This draft was sent out to the relevant ETC-Partners contributing to this project for comment and completion (deadline:18 March 96),

The final working paper including the list of "Human interventions in the hydrological cycle", complete with definitions and including an annex of proposed key words/figures to describe the ʎunɯn inventions ʍɑs distributed (0 ETC/IW partners WRc, AWW, INAG, IOW, NERI and NIVA. Contributors had to select the most significant interventions up (o a maximum of six, with up to three from each main category and for each biogeographic region (deadline for contribution: 19 April 96). The complete list of selected human interventions is attached in Annex 1.

The main categories for human interventions are:

A. River, lake and estuary regulation

B. Water abstraction

C. Activities in the catchment

The selection is bəsɐd on the significance of the physical intervention ənd the importance of its effects. The significance of an intervention has bɐɐn interpreted as being in terms 0 ɛ water volumes involved, economic aspects, population and surface area concerned and the frequency of an intervention in the region.

The importance of the effects, positive and negative, was əssɐssɐd in terms of the number of people affected from the intervention, economic aspects, direct ənd indirect impacts on the environment, fauna and flora, aesthetic impacts and the significance of habitat modification.

The contributors were invited to give a short description and an explanation of the intervention, the extent, the benefits and both positive and negative effects. Added examples complete the contributions.

Note:

The following selection of significant ʎuʍʌn interventions in the hydrological cycle is bʌsɒd on ʌ consultation of experts ʌı AWW (Austria), INAG (Portugal), IOW (France), NERI (Denmark) and NIVA (Norway) ʌnd the results refer only to country specific experiences ʌnd cannot bɒ extrapolated to the whole Europe without further work. These contributions d o not represent official statements of the countries involved.

2. BIOGEOGRAPHIC REGIONS

The nature and impact of human interventions in the hvdrological cycle will be influenced by a number of different factors and these will vary across the EEA area. Climate, geology, soil characteristics, topography, altitude, distance to the oceans and, not least, the historical and current land-use, play a major role regarding the amount of usable water.

Significance, as well as the effects, of a human intervention in the water cycle depend on ecological restrictions. Considering this, a regional-based process of priority evaluation for human interventions in the hydrological cycle was used, in which it was decided in the first case to use the Biogeographic Regions used by the European Topic Centre on Nature Conservation (ETC/NC) for some aspects of its workprogramme. The 6 Biogeographic Regions (Boreal, Atlantic, Continental, Alpine, Mediterranean, Macronesian) have been determined by the European Commission (EC) for the pur-pose of the Natura 2000 process required for the EC Habitats Directive. The definition of the 6 Biogeographic Regions was considered by the Commission to be adequate for political purposes though ecologically it is not precise enough. A more accurate map of ecological regions at a pan-European level is being prepared by the ETC/NC and contains some 30 classes.

The ETC/NC was consulted at the start of this project in order to obtain a consistent approach, where appropriate, between the various Topic Centres of the EEA on regional issues. However, this first overview demonstrates that an approach based on a finer regional scale would appear to be unavoidable.

Furthermore, from the hydrological standpoint, the biogeographical division of Europe does not seem to be logical due to the fact that hydrological characteristics and human pressures vary strongly within a biogeographic region (e.g. Atlantic region of France is separated into three parts). However, it does appear to be appropriate in some countries (e.g. Spain and Ireland). Different areas grouped in the same biogeographic region are sometimes not really comparable (e.g. Alps and Pyrénées are not equivalent and the Norwegian Atlantic region is more related to the Alpine region).

In the hydrological cycle, the geology, the pluviometric conditions, cultural reasons, the human pressure etc. seem to be more important than general climate and altitude, which control the biogeography. Regionalisation is necessary to establish comparability between different areas and nature of the land surface and subsurface and should be part of this classification. Hydrological regionalisation (flow regime classification) is well defined for the FRIEND area (FRIEND 1994). The monthly flow regimes in Europe are divided into 13 classes and their distribution has been mapped over Europe. As this study is further developed under the 1996 Subvention funded work programme we shall be exploring the advantages/disadvantages of biogeographical and hydrological classifications and will attempt to distil the best from each. However, for the purposes of this first phase of the project we persevered with the biogeographical approach.

At the end of this chapter the proposed map of the biogeographic regions used by the European Topic Centre on Nature Conservation and the maps of Austria, France and Norway with some country specific adaptations are given.

7. CONCLUSIONS

1. Major human interventions with significant ecological impact have been identified in all participating countries.

2. The most significant human interventions in the hydrological cycle have been made over the last decades. Today the negative effects of these interventions are recognised and analysed, and restoration activities are initiated. The perception of the importance of an intervention changes over time, as the understanding of the aquatic environment evolves.

3. Key figures and statistics concerning freshwater resources, freshwater abstractions, and major uses by countries are not readily comparable because of the different methods of assessment and calculation in each country. However, comparable data characterising the hydrological cycle, the water balance and water demand are necessary to quantify and judge the human interventions identified in this report, and on the basis of figures which characterise the extent of the impacts (quantity measures), to identify key issues relevant for the EEA.

4. One of the main difficulties in determining the significance of human interventions in the hydrological cycle on a pan-European scale appears to be the lack of appropriate criteria or regional scale for comparison. To that end the use of the regionalisation of the continent by the Biogeographic Regions used for the Natura 2000 process would be inappropriate. From the hydrological standpoint this division of Europe does not seem to be optimal due to the fact that hydrological characteristics vary strongly within a biogeographic region. Interventions in the hydrological cycle are not mainly based on the biogeographic regions itself but rather caused by human pressure (population density etc.) and cultural development. Further, distance between supply and demand, the pressure and the intervention, becomes relevant (e.g. upstream flood control of cities, distant hydropower generation etc.).

5. The report and the selection of the most significant interventions in the hydrological cycle is based on a consultation of experts at AWW (Austria), INAG (Portugal), IOW (France), NERI (Denmark) and NIVA (Norway). Therefore some aspects concerning other countries or regions may have been missed at this stage and will become evident in the further process.