MODELLING OF WATER SYSTEMS FOR PLANNING OF SUSTAINABLE DEVELOPMENT

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Water is the most important strategic resource in world wide. Water is a heritage which must be protected, defended and treated as such. For the European Community (EC), the Water Framework Directive had established the EC action of water policy. Protection and sustainable use of water must be planned and executed in the framework of the river basin. The river basin consists of surface water and groundwater bodies which are interdependent. The territory of Latvia is covered by transboundary drainage basins of the rivers Venta, Lielupe, Daugava and Gauja. Management of these basin water resources is complex, especially, where no EC states Belarussia and Russia are involved.

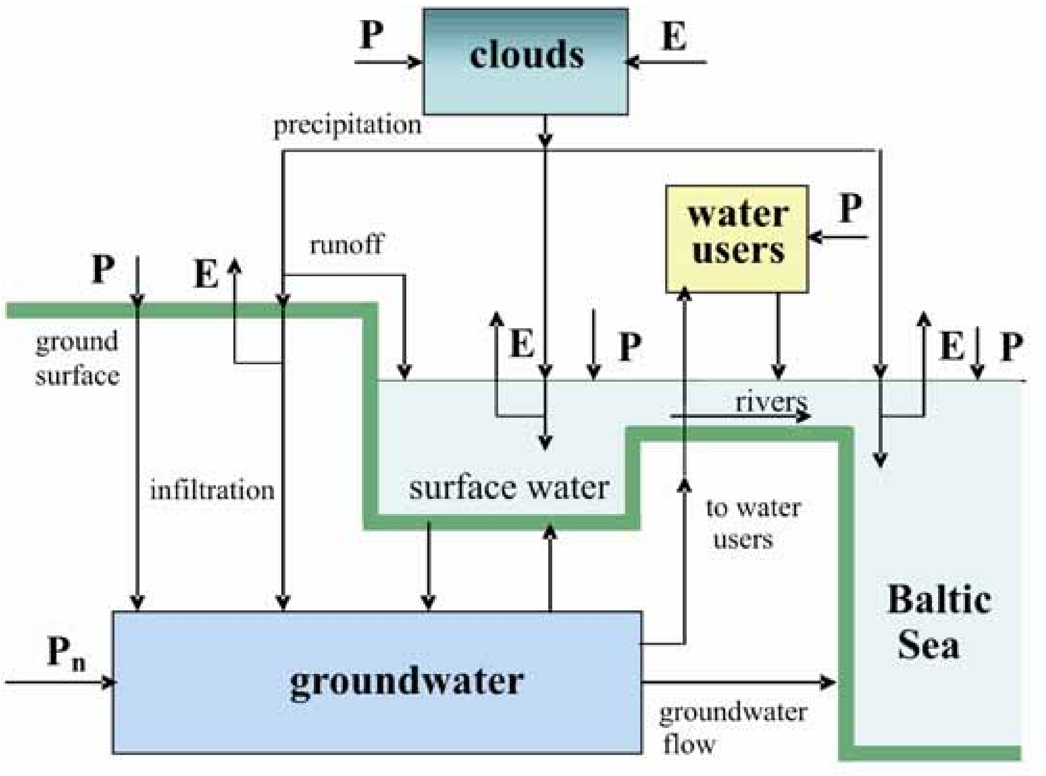

Fig. 1. **Sheme of hydrologic cycle and its pollution sources for Baltic region; E – evaporation; P, Pn – anthropological and natural pollution**

Management means making various decisions aimed at modifying the state of the river basin. To solve the management problem, one must be able to predict the basin response to various operation policies and, by comparing results, to select the best policy. A river basin is involved into the hydrologic cycle shown in Fig. 1. Water is being polluted by natural and anthropological sources. The cycle is under the stress of water users. The task of managing for the river basin is very complex if numerous parameters and constraints regarding water quality and quantity are accounted for. To solve the task, one should possess the following main items: sets of data describing parameters of all cycle components, understanding of processes for the components and knowledge about their interdependence, skill of forecasting behavior of various pollutants in water and the soil.

Presently, numerous software tools have been developed for modeling elements of the hydrologic cycle and also of the cycle, as a whole. However, availability of these tools is not enough to solve the problem of management, because reliability of modeling depends on initial data and also on the skill of using the software.

The main advantage of good modeling is inevitability of initial data validation, because any software should apply them as a concordant system for creating a model. As a rule, this validation takes the most of time. It is quite possible that initial data may be so scarce that modeling has no practical sense for a component considered. Therefore, due to modeling, the weak points of the available data bases can be found and the necessary steps can be taken to fill the data gaps.

For the groundwater and surface water bodies, the main disturbances of their natural regimes are caused by a water withdrawal for large towns and by dams of hidroelectrical plants, accordingly. For the both cases, the main difficulties for a modeller cause vague knowledge regarding the infiltration flow and of the flows joining the groundwater and surface water bodies. None of these flows can be measured practically for the areas considered. Their distributions can be obtained only numerically.

Serious constraints on the water management policy may be set by strongly polluted places endangering both groundwater and surface water bodies. Possible pollutant spill accidents should be accounted for if the risk assessment problem is considered. To forecast behavior of a pollutant and to plan its remediation measures, the special software tools are to be applied. Models predicting pollutant migration are much more complex than the ones applied for simulating the response of a groundwater withdrawal.

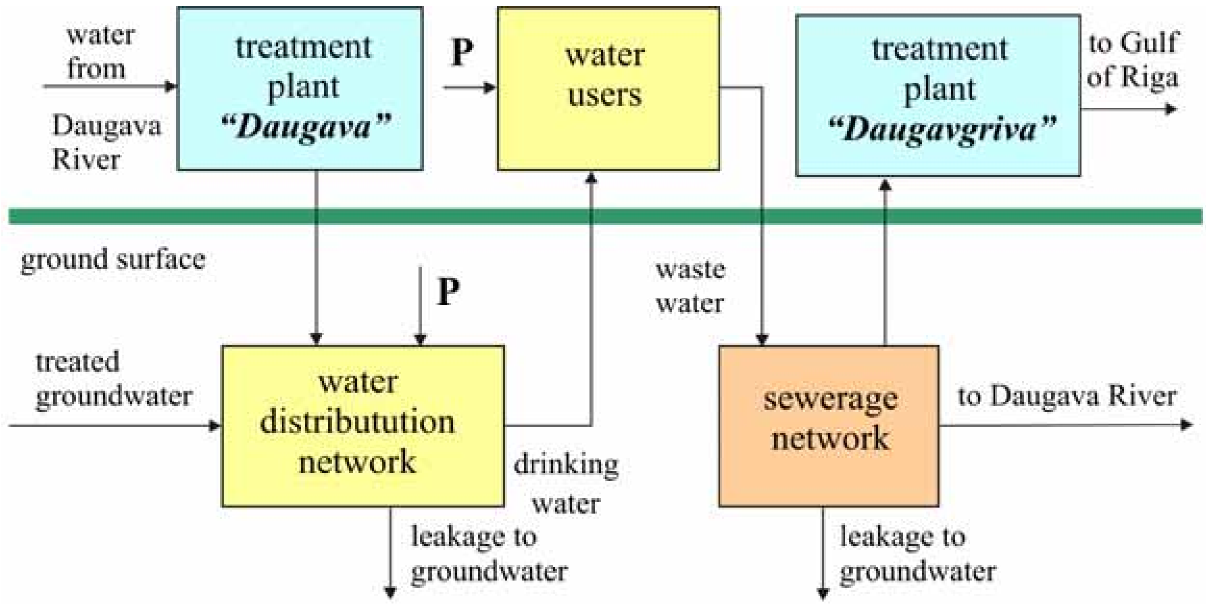

Fig. 2. **Sheme of Riga water system. P – anthropological pollution**

In Fig. 2, as an example of the large town water system and its problems, the scheme for the Riga city is shown. Drinking water for Riga is taken from the Daugava river and from the groundwater sources. Water from the river needs rigorous treatment by the plant "Daugava". Maximal capacity for each water source is ~220 thous m^3/day. Presently, only one half of this capacity is used, because the water consumption of Riga has dropped twice, since 1995, when the wrong decision was taken to renowate both sources, especially the plant "Daugava" . Both water distribution and sewage networks have losses due to leakage. The leakage impact results in rising of groundwater levels and waste water causes serious local pollution. Nowadays, tools for modeling elements of the water system for the large town have been developed and these tools are applied by organizations involved in development of water systems.

Serious problems arise when cross-boundary water systems must be modeled. Even recent geological maps of Latvia provide no data for the cross-boundary zone. If one tries to apply the maps of the bordering countries, there is no guarantee that equal systems of geological layers are used by the countries. Similar situation arises where a sea area is included. The geological data about the sea area practically never are continued inland and otherwise.

For deeper confined aquifers, their borders do not fit, the river basin borders. Then models should be created where parts of different river regions are included.

The above considerations on modeling, as a tool for planning sustainable management of water systems, have been tested by the Environment Modelling Centre (EMC) in the course of modeling various practical problems regarding water supply and pollutant migration. Some comments on the main projects conducted by EMC are given below.

The regional hydrogeological model (HM) "Large Riga" (1993-1996) [1] was a success mainly due to introduction of the original method of computing the infiltration flow. Dynamics of free and dissolved light oil products was modeled for the former Rumbula airport place (1996-2000) [2]. Methods of preventing sea water intrusion were investigated for the Liepaja well field Otanki (2002) [3]. Migration of dense pollutants was modeled for the Bernau place, Germany (2001-2005) [4]. Models were created for polluted area of Incukalns (1998-2005) [5].

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