# REDUCING PHOSPHORUS IN THE DANUBE BASIN

Professor Istvan Ijjas
Department of Water Resources Engineering
Budapest University of Technology
Hungary

Phosphorus is the nutrient which most often limits growth in freshwater systems. Excess growth of plankton has several unwanted effects. It reduces clarity and makes the water less desirable for swimming and inappropriate for drinking. At high plankton densities, the occurrence of toxic algae is more frequent. However, higher plankton productivity may increase the total fish yield and, at the same time, change the species composition, usually to less favoured species when P concentrations are high.

To reduce the load of phosphorus, several abatement measures are available. Some of the measures are local, such as building sewage treatment plants. Others, like imposing a ban or a limitation on the use of phosphorus in detergents, will also affect people living far from eutrophic waters. These two types of measures are analysed in the present study. The study area of the project was the Danube Basin, without Yugoslavia and Bosnia-Herzegovina. The actual area covered is 664,532 km2 which is approximately 82% of the total area of the Danube Basin - 817,532 km2. At least 162 million people live in the Black Sea Basin. About 85 million of these live in the Danube Basin alone.
A major part of the Black Sea - notably the north-western shelf - is critically eutrophic. The Danube, as monitored within the framework of the Bucharest Declaration, currently introduces about 60,000 tons of total phosphorus per year, about the same as the total river input of P to the North Sea and four times that to the Baltic. There has been an enormous increase in the nutrient load to the Black Sea in the past 25 years, probably as a consequence of the widespread use of phosphate detergents and intensification of agriculture.

A consortium consisting of SENATOR Consult Ltd., VITUKI Consult Rt., RIIDHE and WRI was formed specifically for the purposes of this project. In addi-tion to the consortium, the following local organisations and consultants worked on the project: Institute of Water Quality and Waste Management, Technical University of Vienna, Austria; University of Zagreb, Croatia; Morava River Basin Authority, Czech Republic; German Association for Water Resources and Land Improvement and the German National Committee of ICID, Germany; IPICON Ltd., Hungary; National Institute of Ecology, Moldova; National Institute of Chemistry, Slovenia; Institute for Sustainable Development, Ukraine; University of Technology Delft, Centre for Comparative Studies on River Basin Administration, The Netherlands; Alfred Hamm and Wolfram Dirksen, Germany; Norbert Matsche, Austria; Vera Jahnová and Jana Jelinková, Czech Republic; Oskar Pisoft, Dagmar Drahovská, Pavel Hucko and Elena Rajczyková, Slovakia; Viktor Grilc, Slovenia; Ferdo Basic, Stjepan Madar and Frane Tomic, Croatia; Károly Bögi project director, István Ijjas project manager, Attila Krauze, Imre Petneházi, Zsuzsanna Szabó, Imre Szebényi, Lajos Szépkúti co-ordinator of the Hungarian team and Katalin Zotter, Hungary; Costel Negrei and Florin Alexandru, Romania; Vladimir A. Demkin and Vadim Dukanov, Ukraine; Dumitru Drumea, Ruslan Melian and Valeriu Mosanu, Moldova; Ivan Varlev, Boytcho Tenev and Nikolay Tzankov, Bulgaria; and, Johann Wessel, The Netherlands.

The following 10 tasks were executed by the country teams:

- detergents used in the Danube Basin countries
- detergents produced in the Danube Basin countries
- surface water P-load in the Danube Basin
- autonomous development scenarios in the Danube Basin countries
- legal situation related to P in detergents and P-removal from waste water
- problems in relation to a fast change to P-free detergents in the Danube Basin
- alternatives for solutions to overcome the problems
- feasible development scenarios for the Danube Basin
- costs and benefits of the scenarios
- environmental effects of substitutes of P and other surfactants

The synthesis of reports on these tasks, edited by the project manager, benefited substantially from the comments made by the experts participating in the Workshop, held in Visegrad, Hungary, in November 1995. The final report of the project has been heavily modified after receiving very important comments, and due criticisms, from the Danube Program Co-ordination Unit, from EU experts - W. Dirksen, A. Hamm, N. Matsche and J. Wessel - from the representatives of two NGOs - Veronica ECO-Counselling, Czech Republic, and EMLA Environmental Management and Law Association, Hungary - and from participating local experts.

**Detergents used in the Danube Basin countries**

The annual specific per capita consumption of detergents has sharply dropped in the last years in some of the Danube Basin countries. This drop is partially compensated by home-made soaps in agricultural regions and small towns. The annual specific per capita consumption of detergents in recent years varies from about 1.0 to 11.6 kg in the Danube Basin countries. This represents approximately 85-90% of the total household consumption of phosphate containing detergents and only 10-15% of the total industrial consumption, especially in commercial laundries.

Since about the late 1980s, there has been virtually no phosphate in the detergents used in Germany and Austria. Less than 25% of the detergents used in Slovenia contain phosphates. Phosphate-free detergents were used only in small quantities in the past in the Czech Republic (20 %), the Slovak Republic (10 %), Croatia (10%) and Hungary (10%). Virtually no P-free detergents are used in the other downstream countries. The average P concentration of the P-containing detergents varies from about 3.5 to 7.5 % in the Danube Basin countries.

There is a great potential for reduction of the use of phosphorus in detergents. A recent market analysis showed that significant quantities of phosphate-containing detergents are still in use in some of the Danube Basin countries. It is estimated that the total potential for reduction of the use of phosphorus in detergents in the Danube Basin countries could amount to about 15,000 tons P/year.

**Detergents produced in the Danube Basin countries**

The structure of detergent production has changed during the last four to five years in most of the Danube Basin countries. Detergents were produced almost exclusively by state companies earlier, but this has changed now. The majority of detergent production is mostly carried out by multinational companies in the Czech Republic, the Slovak Republic, Slovenia and Hungary. Associations of Detergent Producers were established in the Czech Republic and in Hungary. Members of these Associations produce 85-95% of all detergents. The domestic production of detergents has decreased over the last five years in Croatia, Hungary, Romania, Ukraine and Bulgaria. The production and use of detergents has dropped mainly because of the economic crisis and detergent imports.

There are many different types of detergents produced and imported in the Danube Basin countries, as indicated in the Country Reports. Trade flows of detergents between EU countries and Central European Countries, and also within Central European Countries, have expanded during the last years. The analysis of the volume of trade shows that the Czech Republic, Slovakia, Slovenia and Hungary import detergent products mainly from the EU countries. Romania, Ukraine and Moldova imports from EU countries are very limited in terms of volume and value. The amount of imported detergents is significant in Slovakia, Hungary, Romania, Ukraine, Moldova and Bulgaria.
Zeolit-A is most commonly used in Slovakia, Hungary and Moldova for replacing the water-softening properties of phosphates in detergents. It is not possible to ban or restrict the import of P-containing detergents to Ukraine, because of health problems. The Ukrainian population uses half the amount of detergents per person than the population of other European countries. This has resulted in an increase in infectious diseases. Ukraine does not restrict the import of cheap detergents, independent of their composition.

**Surface water P-load in the Danube Basin**

About 70 million people - 83% of the total population of the Basin - live in the studied area. The German and the Austrian portion of the Danube Basin - the P in detergents is no problem in these countries - includes 16 million inhabitants, or 20% of the total population of the Danube Basin.

Municipal wastewater is one of the main sources of P-load into the surface waters in the Danube Basin. In 1995, out of a total population of 25 million - 46% of the total population - connected to public sewerage in the studied catchment area of the Danube, not including Germany and Austria, 10 million - 18% - had no treatment; 3 million - 5.5% - had only primary treatment; 12 million - 22% - had primary and secondary treatment; and 0.25 million - 0.5% - had secondary and tertiary treatment. The total treatment capacity for municipal wastewater was 28 million inhabitants in 1995, or 40% of the people living in the studied catchment area - the Danube Basin, not including Yugoslavia and Bosnia-Herzegovina.

A market analysis carried out by the consultants in different countries showed that significant quantities of phosphate containing detergents are in use in the studied Danube Basin countries, of which 6,000 tons P/year is collected by sewers and 5,100 tons P/year enters into surface waters. The amount of P from detergents makes up 5-41% of the total P-load.

A new legal measure for environmental management, the PhöchstMengV, has reduced the phosphate load on lakes, reservoirs and rivers in Germany, but not to a sufficient extent to solve eutrophication problems as a single measure. However, it can be concluded that phosphate-poor detergents have initiated a general decrease in phosphates in rivers.

**Autonomous development scenarios in the Danube Basin countries**

The consultants from the different countries have provided information in the Country Reports about the expected results of the measures taken or planned between 1995 and 2005, to reduce phosphate inputs from municipal treatment plants by new and upgraded existing sewerage

and wastewater treatment facilities. These measures were considered as autonomous development scenarios.

Sewerage extension will cause a major increase of surface water P. This is because, in the case of septic tanks and pits, the total surface water P-load is less than in the case of linked sewerage, even when secondary treatment is foreseen. Without tertiary sewage treatment, surface water P-load will drastically increase.
It is expected that by 2005, at least 46.5 million - 66% of the total population of the studied area, including Germany and Austria - will be connected to sewerage and 42.5 million - 61% of the total population of the studied area - will be connected to wastewater treatment plants. Wastewater from 16 million inhabitants - 23% of the total population - will be treated by secondary and tertiary treatment; wastewater from 23 million inhabitants - 33% of the total population - will be treated by secondary treatment and wastewater from 3.5 million inhabitants - 5% of the total population - by primary treatment only. Wastewater from 4 million inhabitants - 5% of the total population - will receive no treatment.

In 2005, it is estimated that 56% - 39 million - or more of Danube Basin inhabitants connected to sewerage will have secondary and tertiary sewage treatment. The percentage connected to sewerage with tertiary treatment is estimated at 23% - 16 million - for 2005. Experts from Slovakia, Slovenia, Croatia, Hungary, Ukraine and Moldova have reported that they will not discharge any untreated sewage in 2005, whilst the Czech Republic expects to still discharge approximately 9%, Romania 13% and Bulgaria 20% of untreated household wastewater to the public sewerage system.

Based on the above-mentioned figures, it is estimated that the total detergent P reduction potential for the Danube Basin will amount to about 7,400 tons P/year in 2005, from the 46.5 million inhabitants - 66% of the total population - connected to sewerage. Other uses of P in cleaning agents, such as machine dishwashing agents, in most of the countries are not included. They are estimated to amount to an additional 740 tons P/year.

**Legal situation related to P in detergents and P-removal from wastewater**

The legal situation in countries like Germany, Austria and Hungary is satisfactory. Slovenia should enact modern P regulations for sewage treatment plants. It might be expected that in these countries the laws will be effective enough to balance the costs of enforcement. In the Czech Republic the system of a voluntary agreement has been chosen. The effectiveness of this system should be proven by an effort of evaluation. Maybe Croatia could follow the same line.

In the Slovak Republic, Bulgaria and Romania no laws for P control seem to be in operation. In these cases, it might be wise to consider a system of voluntary agreements, as was introduced in the Czech Republic. Depending on who is responsible for the exploitation of wastewater treatment plants, covenants on their construction and operation could also be developed. In countries like Moldova and Ukraine introducing a system of P-control for the time being should be made on an ad hoc basis, with the donor countries starting negotiations with governments on conditions about P-removal for the financing of industrial plants in the most sensitive areas. It has become clear that in many countries several different organisations contribute to phosphorus management.

**Problems in relation to a fast change to P-free detergents in the Danube Basin**

The following main observations concerning the constraints and problems in relation to a fast change to P-free detergents were reported by the consultants:

- *Constraints/problems with government agencies responsible for legislation and public administration:* political interest for environmental policy is low; no comprehensive phosphate policy; law enforcement is weak; the process of law-making takes a long time, and law drafting and passing is very hard; costs for meeting EU surface water quality standards and National Standards are tremendous; fine systems are inefficient for water quality control and the fine levels are too low; no standards for P content/concentration
- *Constraints/problems with detergent producers*: concentrated detergents were not on the market; small amounts of P-free detergents on the market; P-free detergents are more expensive; there is no domestic production of P substitutes
- *Constraints/problems with others:* Public information on environmental problems related to detergents is poor; P content is not indicated on detergent products; public awareness of environmental matters is poor; there is no NGO activity for introduction of P-free detergents; other issues are more important; high demand for low quality/low price products; consumers are mainly interested in the price of detergents; wastewaters discharged to rivers are highly diluted and P removal is practically negligible from the viewpoint of local water quality concerns; the contribution of P from detergents to the phenomenon of eutrophication is small; local and regional problems may not be handled simultaneously; sanitary problems and the increase of infectious diseases

**Alternatives for solutions to overcome the problems in the Danube Basin**

The consultants described the most likely abatement measures for reducing phosphorus loading from the population in the Danube Basin. Table 1 presents an overview of the main phosphate policy measures selected by consultants from different countries. Two types of measures were analysed in the present study, in detail: P-removal from detergents and P-removal from wastewaters.

**Feasible development scenarios for the Danube Basin**

Surface water P-loads from detergents were estimated for 2000 and 2005. P-load reduction for 2005 is quoted at 20-63% by Scenario A and at 30-90% by Scenario B. The estimated percentage reduction is 29% according to Scenario A and 72% based on Scenario B. (Figure 1,2)

**Table 1**. Alternatives for solutions to overcome the problems

| Country | P-removal from detergents | P-removal from waste-waters |
|---|---|---|
| Czech Republic | -implementation of voluntary agreement -ecological education | -enforcement of legal measures -development of the fee -system of WWTPs* -construction, upgrading WWTPs |
| Slovakia | -legal measures for limitation of the P- content of detergents -price policy for the P-free detergents-education | -construction and upgrading of WWTPs |
| Slovenia | -international agreements -internationally recognised green label (imposing more requirements, not only P content) | -construction and upgrading of WWTPs including tertiary treatment |
| Croatia | -introduction of P-free detergents | -construction and upgrading of WWTPs |
| Hungary | -voluntary agreement between government and manufacturers -improvement of public awareness -introduction of the European Eco-labelling System for Detergents -introduction of P-free detergents | -upgrading of the existing and construction of the new WWTPs with tertiary treatment -EU harmonisation |
| Romania | -public involvement -economic incentives -administrative restrictions -alternative technical solutions | -construction, upgrading WWTPs |
| Ukraine | -partial substitution of P by Zeolit | -construction, upgrading WWTPs |
| Moldova | -new legal act limiting P in detergents-international financial support-subsidies for P-free detergent prices-taxes-legal enforcement-intensification of NGO activities | -new standards -international financial support -construction and upgrading of WWTPs |
| Bulgaria | -control of import-export -EU harmonisation -voluntary agreement -taxes -improvement of public awareness -advertisement | -EU harmonisation -construction and upgrading of WWTPs |

*WWTP - Wastewater Treatment Plant

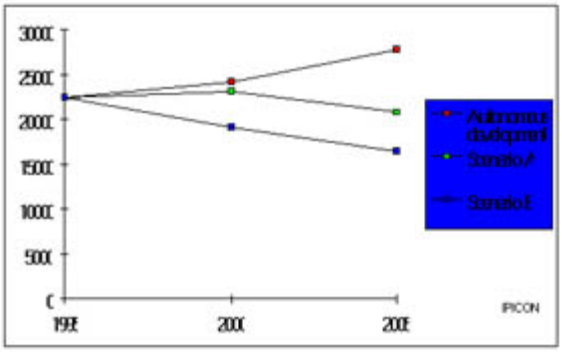


**Figure 1**. Expected trends in P-loads from detergents in the Danube Basin (tons/year)

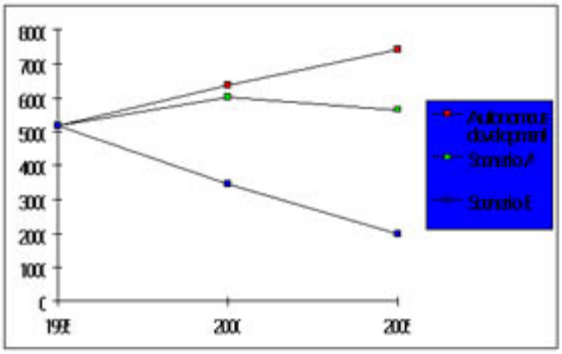

**Figure 2**. Expected trends in non-detergent related P-loads in the Danube Basin (tons/year)

The information presented by Haskoning in the Final Report of the Danube Integrated Environmental Study and the relevant Country Reports were used by most of the consultants in the present studies. According to the Haskoning Report, elimination of phosphate containing detergents could reduce P-emissions substan-tially. The agreement is good between the reduction potential estimate given by Haskoning and the present study. The potential for change in P-emissions, by elimination of P in detergents in 2005 will be 2,129 tons P/year, in the case of Scenario A, and 5,339 tons P/year in case of Scenario B (Figure 1,2).

According to Haskoning, banning the use of phosphate from detergents is a very cost-effective way of reducing phosphorus emissions and the impact on the price of detergents is marginal. According to the Country Reports of this study, banning the use of P in detergents is not recommended.

The reduction potential of P in detergents and the expected time-frame for completing the P control programs are different in the Danube Basin countries. The size of the P-control measures and the timing of the programs should be described for individual countries or groups of countries.

**Costs and benefits of the scenarios**

No cost estimates exist for the introduction of P-free detergents in most of the Danube Basin countries. It was reported by the consultants from the Czech Republic, Germany, Hungary, Slovenia and Bulgaria that the introduction of P-free detergents should not significantly increase the cost of P-containing detergents. The elimination of phosphorus from detergents should be combined with intensified research and development of alternative components and washing technology, so that the total cost of washing is not increased. At the same time, washing efficiency should not be affected. Higher prices of P-substitutes should be compensated with lower amounts of the washing agent needed. Information on the cost of P-removal from detergents is extremely scarce in the literature. According to Laws, the incremental cost of P-free detergents to the consumer would be about US$ 2 per person per year.

According to Huppes et al., emission reduction can be made profitable by financial instruments, by putting a price on emissions. The critical emission "tax" level is ECU 11.50 per kg P for the removal of P from detergents. Several aspects of the costs of P-free detergents are subject to discussion: washing time, washing costs and social costs as a loss in employment.

In the literature, orientation costs are given for the construction and operation of wastewater treatment plants of various sizes. The cost ranges are large, an element which may be acceptable due to different ways of realising technologies. The costs also vary from one estimate to the other. For detailed studies, technological calculations can not be avoided in making decisions. There is also a wide variation among countries. The combined reduction in phosphorus by sewage treatment and detergent P-control is not equal to the simple sum, because some of the phosphorus in the detergents will also be removed at the sewage treatment plant. Several of the assumptions used in studies on costs of P-removal in wastewater treatment plants are subject to discussion. The cost of building sewage treatment plants may be too high. The plant also removes bacteria and other toxic substances; thus as an option only part of the cost of building and maintaining sewage treatment plants and piping could be assigned to phosphorus reduction. However, it is presently difficult to see how cost-sharing should be done.

The following benefit categories concerning the scenarios were studied: money saved, which will not be invested in wastewater treatment plants - P-removal from detergents instead of P-removal at wastewater treatment plants; costs of damages or the expected remediation of damages after the implementation of the scenarios.

The lack of relevant data was generally regarded as the biggest obstacle to performing and using benefit assessment. The case studies in the references mentioned in this paper were used by most of the consultants in the benefit studies, because of insufficient data.

Several methods for evaluating water quality improvements have been developed by economists. However, there is no consensus regarding which methods are to be used in practice. For a first-order-of-magnitude estimation of benefits, it is possible to use existing benefit research. It was therefore recommended by Kuik et al. to develop a European database, with benefit studies as a tool, and using the EC Guidelines for

Benefit Assessment of Environmental Measures.

The database could contain systematic summaries of studies that are easily accessible via key words such as "type of environmental problem," or "benefit categories included." If this database is regularly updated with the most recent research efforts in this field, it will contain a wealth of information for European researchers and decision makers. It will avoid much double work and will therefore prove to be extremely worthwhile.

There is a great variation among countries concerning each of the cost and benefit categories. The values laid down in the different countries are not identical. When interpreting the figures, it should be borne in mind that definitions and estimation methods may vary from country to country, and that comparisons among countries should be subject to caution.

It was concluded that there was no data available, or that there was insufficient data, for assessment of costs and benefits of P-removal from detergents in the Danube Basin scale. No uniform data on costs and benefits exists for the whole of the Danube Basin, therefore data are given for the individual countries only.

Investment and operation costs for extended sewage purification are relatively high. While the comparison makes detergent P-removal seem much more cost effective than P-removal at sewage treatment plants, one should keep in mind that detergents never accounted for more than 50% of the P in municipal wastewater.

**Environmental effects of P-substitutes and other surfactants**

Three overall conclusions, based on the review, were reached: (a) Replacing the phosphate in detergents with Zeolite-A will not be dangerous for human health, and there will be no disadvantage to the environment. (b) All appropriate steps should be taken to encourage industries to develop phosphate substitutes that are harmless to the environment. (c) Monitoring programmes should be adapted to analyse the fate of new chemicals likely to be introduced into sewage sludge and aquatic ecosystems, as a result of the use of phosphate substitutes in detergents.

**Conclusions**

A number of main general observations can be made, which are based on the Task Reports as reviewed in the preceding chapters and in the Country Reports:

*P-free detergents*

Phosphate substitutes and their significance for the environment is a very important consideration when phosphate-free detergents are being introduced, however only very few relevant studies have been carried out in the downstream countries of the Danube Basin. Phosphate-free detergents can reduce the phosphate load in surface waters to a significant extent and must be regarded as a fundamental and generalised measure to reverse the trend of increasing phosphate loads in the Danube The criteria for selection of environmentally-friendly detergent products should focus on:

- reduction of the load and impact of detergents to the necessary extent - criteria on dosage, soluble/insoluble inorganic compounds, aerobic/anaerobic biodegradable ingredients
- preference on those ingredients undergoing quick and ultimate biodegradation and having the lowest possible negative effects on aquatic system, considered under the criterion of critical dilution volume - reduction of relative risk
- non-use of ingredients which are known to show adverse effects to the aquatic environment, i.e. EDTA, APEOs
- restriction of ingredients having acute toxicity and combinations with low biodegradability and/or accumulation potential

Consumers should be better informed on the environmental impacts of the products. The introduction of phosphate-free detergents alone is not sufficient to reduce the phosphate load and eutrophication of rivers and other receiving waters to a tolerable extent. In addition it is necessary to improve sewage purification including tertiary treatment (phosphate elimination) and to take measures to reduce inputs from diffuse sources, especially from farming. Elimination of phosphorus from wastewater, regardless of its origin, is an important option. Construction of new treatment plants or facilities for tertiary treatment is strongly needed for overall nutrients control, not only for phosphorus. This option is, however, the most costly and time consuming. The difference between the costs of sewage treatment and costs of removal of P in detergents in the short term could be considered as benefits.

Different scenarios or sub-scenarios are possible to achieve the same targeted reduction of P in surface waters. This is the so-called "emission mix" within the above mentioned scenarios. The results of scenarios and sub-scenarios show what strategy is the most cost-effective. In other words, which "emission mix" guarantees the highest P reduction at the lowest cost in the long term.

Differences among the various Danube Basin countries or various groups of countries lead to different choices of P-control measures and mix of the measures. Such differences concern basic principles of environmental policy, policy structures and policy environments.

*Wastewater treatment*

Improving sewage treatment and controlling diffuse inputs are long-term measures compared with the introduction of phosphate-free detergents, which can be done more or less instantaneously. Tertiary treatment in all sewage treatment plants is not likely to be a realistic approach. The new generation of wastewater treatment plants should at first be aimed at removal of organic matter and phosphorus.

*Market-oriented measures*

There is a lack of experience and expertise, in the downstream countries in the Danube Basin, with designing and implementing market-based environmental policies and mechanisms. While some types of pollution charges and fines have officially been in use in some of the countries for many years, such mechanisms often existed only on paper or were mainly symbolic.

The fine system is one of the main environmental enforcement tools. However, in practice, a system of fines is not effective as an enforcement tool. The levels of the fines are far too low to give an incentive to change polluting behaviour and to prevent future pollution. It is expected that, in the short term, the fine levels will be updated, while, in the long term, the fines will be replaced by pollution charges.

Additional knowledge and expertise is needed to maximise the effectiveness and efficiency of economic instruments for the control of the P content of detergents. The capacity of environmental authorities and industrial managers to develop and operate economic instruments should be enhanced through training, information exchange and dialogue building.
P-reduction can be made profitable by financial instruments, by putting a price on P-emissions. The "critical P-emission tax" principle could be introduced for removal of P in detergents. Use and interpretation of this principle differs, however. A product charge could be applied to cover environmental expenditures, relating to the damages caused by the P-containing detergents. Its environmental effectiveness depends on the extent to which the necessary expenditures are covered. It is efficient to charge consumers for P-containing detergents if the charge affects consumption of such detergents. According to the literature, tax differentiation seems to be one of the more successful economic instruments and its application, therefore, is recommendable for introduction of P-free detergents.

Many countries have a substantial practice of applying subsidies as instruments for realising their environmental policy objectives. In general, the acceptability of financial assistance is greater when the related environmental problem is felt to be more severe, as in the case of eutrophication of surface waters. This might suggest that financial assistance is an important instrument in establishing a P-free/P-reduced Detergent Action Program in the Danube Basin. However high subsidy shares in investment costs of wastewater treatment plant construction programs induce plant operators to design capital-intensive facilities with too much reserve capacity and use of P-containing detergents as a consequence. This leads to inefficient solutions. Subsidy systems for detergent production and consumption could speed up development of the detergent industry and trade and contribute to introduction of P-reduced and P-free detergents.

*Public awareness and information*

Public awareness of environmental matters in the downstream countries of the Danube Basin has been growing during the last years; however, other issues are considered more important: unemployment, inflation, increasing prices and low salaries, which reduces willingness to pay for solving water pollution problems.

Public information on environmental problems related to detergents is poor. There are P-free detergents on the market in some of the countries with similar prices as the P-containing detergents, but those are not used by the public. Improvement of public information and awareness must be an integral part of the P-removal policy.

*Legal measures*

As a result of European agreements, there is a need for the downstream countries of the Danube Basin to "harmonise" their environmental legislation and activities with EU legislation and activities, and to become more closely integrated, politically, economically and socially, with the EU. The introduction of an internationally recognised eco-labelling system would stimulate better sales records for the producers of P-free detergents. This will force other producers to follow suit. The green label should also impose additional requirements. Voluntary agreements between the producers of detergents and the responsible government agencies are recommended for the removal of P from detergents.

***Recommendations***

The major measures recommended for policy on phosphate removal from detergents and municipal wastewaters are as follows (Table 2):

**Table 2**. Short term and long term action plan for P-removal

| ACTIONS | Short term | Long term | | Responsible agencies |
|---|---|---|---|---|
| | 1995-2000 | 2000-2005 | 2005-2010 | |
| **Improvement and intoduction of non-structural measures for detergent policy** | | | | |

| | | | | |
|---|---|---|---|---|
| Updating the standards for detergents and for WWTPs - EU harmonisation | ■ | | | GO, EU, DM, DC |
| Improvement of market-oriented measures (fines, taxes) | ■ | | | GO, EU |
| Improvement of public awareness, information and involvement | ■ | ■ | | GO, NGO, P, DM |
| Voluntary agreements between the government and manufacturers | ■ | ■ | | GO, DM, EU, NGO |
| Capacity building - training - education | ■ | ■ | ■ | Capacity building - training - education |
| Introduction of the European Eco-labelling System for Detergents | ■ | | | GO, EU, NGO, DC, DM, P |
| **Improvement and introduction of technical measures for detergent policy** | | | | |
| Introduction of P-free detergents | ■ | | | GO, DM, EU NGO |
| Introduction of environmentally friendly P-substitutes | ■ | | | GO, DM, NGO |
| Construction and development of WWTPs in a multi-stage fashion | ■ | ■ | ■ | GO |
| Introduction of tertiary treatment | ■ | ■ | ■ | GO, EU, NGO |
| Cost-effective WWT technologies | ■ | ■ | | GO, EU |
| Upgrading existing WWTPs | ■ | | | GO |

GO= Governmental Organisations, NGO= Non-Governmental Organisations, EU= European Union, DC= Danube Committee, P= Public, DM= Detergent Manufacturers

-*Improvement and introduction of non-structural measures for detergent policy*: improvement of direct regulation systems, updating the standards for detergents; introduction of voluntary agreements between detergent producers and the responsible government authorities to introduce environmentally sound detergents; improvement of public awareness of environmental problems caused by detergents; introduction of the European Eco-labelling System for Detergents; improvement of financial measures for sustainable use of detergents

-*Improvement and introduction of structural/technical measures for detergent policy*: Introduction of P-free detergents; P-removal from waste waters

While each country is specific and so differs from others, the general concept is that environmental policy is a priority requirement and that the approach and the process of detergent policy management can be developed.

**Acknowledgements**

All country teams of the project are grateful for the support of the European Commission in providing funds for this research. The project manager expresses appreciation for the professional support provided by local experts in individual riparian countries. Special thanks to the following national co-ordinators and experts from EU member countries: Wolfram Dirksen, Alfred Hamm, Alfred Matsche and Johann Wessel. Without their professional work, the preparation of this report would not have been possible.

Special thanks also to the representatives of the Program Co-ordination Unit, Vienna, and to Teun Botterweg, George Chabrzyk, László Kardoss, Kees J.M. Kramer and Dávid Rodda. Significant additional contributions were provided by the ministries and organisations who supported the project with information and recommendations. The co-operating organisations and their representatives at the Workshop in Visegrad are thanked for their support and contributions to the meeting and their proposals for useful follow-up activities.

**References**

1. Dirksen W. (1995) Efforts to reduce nutrient emissions in rivers in Germany and of the Danube Basin. Workshop on Removal of Phosphate from Detergents in Countries in the Danube River Basin, Visegrad
2. EBRD-CEC (1993) Environmental standards and legislation in Western and Eastern Europe towards harmonisation. Water Sector

Case Study, Part I
3. Fleckseder H. (1993) Estimates for the sources of N and P and the discharge to sea for the rivers Rhine, Elbe and Danube. 9th European Sewage and Refuse Symposium, Symposium of the International Solid Wastes Association, Munich
4. Hamm A. (1995) Introduction of phosphate-free detergents in the Danube Basin: report from Germany. European Union Study
5. Haskoning (1994) Environmental Programme for the Danube River Basin. Danube Integrated Environmental Study, Final Report
6. Huppes G., van der Voet E., van der Naald W.G.H., Vonkeman G.H. and Maxson P., (1992) New market-oriented instruments for environmental policies. Graham & Trotman
7. Klarer J. (ed.) (1994) Use of economic instruments in environmental policy in Central and Eastern Europe. Regional Environmental Center for Central and Eastern Europe
8. Kuik O.J., Oosterhuis F.H., Jansen H.M.A., Holm K., and Ewers J. (1992) Assessment of benefits of environmental measures. European Communities Environmental Policy Series, Graham & Trotman
9. Mee L.D. (1992) The Black Sea in crisis: a need for concerted international action. AMBIO Vol.21.No.4. June 1992
10. Navrud S. (1993) Pricing the European environment. Scandinavian University Press
11. Oslo and Paris Commissions (1994) Draft report on nutrients in the convention area, overview of implementation of PARCOM recommendation 88/2. Oslo and Paris Conventions for the Prevention of Marine Pollution Programmes and Measures Committee (PRAM)
12. Rodda D.W. (1994) The environmental programme for the Danube River Basin. Water Quality International 94, IAWQ 17th Biennial International Conference, Budapest, Hungary
13. SENATOR (1996) Removal of phosphate from detergents in the Danube Basin. In: Ijjas I. (ed.) Final Report, Volume I. Environmental Programme for the Danube River Basin, PHARE Programme, Project No: EU/AR/205/91

---

Professor **Istvan Ijjas** is Professor of Water Resources Engineering at the Department of Water Resources Engineering, Budapest University of Technology. He is Member of the Board of Directors of the Environmental Management and Law Association, Honorary Vice President of the ICID and Secretary of the ICID European Working Group. He has published numerous publications and technical reports on water resources and environmental engineering, and was Project Manager of the Removal of Phosphate from Detergents in the Danube Basin PHARE Project, Co-ordinator of the Hungarian team for the Danube Integrated Environmental Study PHARE Project, Hungarian National Co-ordinator of the Review of River Basin Management Practices in the Danube River Basin PHARE Project, Co-ordinator of the Rhine-Danube Project and Partner of Equipe Cousteau in the Programme "The Danube ... for Whom and for What?" Currently, he is Co-ordinator of the EUROWATER-CEC (Central European Countries) Project.