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CHARTER **on** **ground-water management**

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FOREWORD

Ground water - as a natural resource with both ecological and economic value - is of vital importance for sustaining life, health and the integrity of ecosystems. This resource is, however, increasingly threatened by over-use and insidious long-term effects of pollution. Pollution comes from both point sources and diffuse sources. Potential risks or actual impacts could permanently impair underground water resources, with far-reaching and unpredictable implications for present and future generations. Action is urgently needed. The *Charter on Ground-water Management* provides policy measures for such action.

The adoption of the *Charter* by the member Governments of the Economic Commission for Europe was the culmination of intense regional co-operation aimed at reaching agreement on common policies for the protection of this vital natural resource. Prepared by the Senior Advisers to ECE Governments on Environmental and Water Problems, assisted by the Working Party on Water Problems, the *Charter* builds on the results of extensive experience. It reflects, in particular, the outcome of two special meetings devoted to the subject: the Seminar on Ground-water Protection Strategies and Practices, held in Athens (Greece) in 1983 and the Seminar on Protection of Soil and Aquifers against Non-point Source Pollution, held in Madrid (Spain) in 1987.

The *Charter on Ground-water Management* gives broad support to ECE member Governments in their common endeavours to protect ground water by providing planners and decision-makers with appropriate policy instruments. Publication of the *Charter* is intended to heighten public awareness of the need for concerted action to protect ground water. The Commission has recommended that member Governments apply the provisions of the *Charter* when formulating, adopting and implementing water-related policies and strategies at both national and international levels.

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Contents

		Page
I.	Ground-water policy	1
II.	Ground-water strategies	1
III.	Integration of instruments	2
IV.	Ground-water allocation	2
V.	Ground-water legislation	3
VI.	Competence	4
VII.	Economic measures	5
VIII.	Permit and penalty system	5
IX.	Exploration and abstraction permits	5
X.	Abstraction and recharge permits	6
XI.	Pollution-control permits	7
XII.	Wells and boreholes	9
XIII.	Monitoring and control	10
XIV.	Impact assessment	11
XV.	Inventories	11
XVI.	Planning and forecasting	12
XVII.	Land-use policies	13
XVIII.	Protection zones	14
XIX.	Pollution from agriculture	15
XX.	Pollution from urban and industrial sources	16
XXI.	Control of mining activities	17
XXII.	Heat pumps	17
XXIII.	Research	18
XXIV.	Education and information	19
XXV.	International co-operation	20

I. GROUND-WATER POLICY

Governments should formulate and adopt a long-term policy to protect ground water by preventing pollution and over-use. This policy should be comprehensive and implemented at all appropriate levels. It should be consistent with other water-management policies and be duly taken into account in other sectorial policies.

II. GROUND-WATER STRATEGIES

1. As ground water should be recognized as a natural resource with economic and ecological value, ground-water strategies should aim at the sustainable use of ground water and preservation of its quality. These strategies should be flexible so as to respond to changing conditions and various regional and local situations.

2. Ground-water pollution is interrelated with the pollution of other environmental media (surface water, soils, atmosphere). Ground-water protection planning should be incorporated into general environmental protection planning.

3. Protection measures aimed at prevention of ground-water pollution and over-use should be the basic tools for ground-water management. Such protection measures include, *inter alia*, monitoring of ground waters, development of aquifer vulnerability maps, regulations for industry and waste disposal sites paying due account to ground-water protection considerations, geo-ecological assessment of the impact of industrial and agricultural activities on ground waters, and zoning of ground-water protection areas.

III. INTEGRATION OF INSTRUMENTS

1. In formulating and implementing national ground-water policy, legal, administrative and regulatory measures should be co-ordinated with the best available technologies and economic instruments.
2. Integrated water management should be promoted by paying equal attention to both quantity and quality aspects of ground water. Likewise, emphasis should be placed on the co-ordinated management of ground water and surface water, while taking into account the distinguishing features of ground water as compared to surface water which necessitate special protective measures for aquifers.

IV. GROUND-WATER ALLOCATION

An appropriate policy should be adopted for preferential allocation of ground water, giving appropriate weight to competitive uses and balancing short-term demands with long-term objectives in the interest of present and future generations. In allocating ground-water resources, account should be taken of the amount of ground water in reserve and of the rate of its replenishment. Allocation of high-quality ground water only to uses demanding high-quality water, in particular for human and animal consumption, should be encouraged. More emphasis should be given to the nature conservation value provided by ground-water resources, in particular where nature protection areas are vulnerable to changes in ground-water conditions.

V. GROUND-WATER LEGISLATION

1. Provisions of the Charter should be applied in national ground-water legislation. Legal provisions specific to peculiarities of ground-water management should be formulated and promulgated. Legislation should contain provisions for its effective implementation including the mandate, competence and power of the relevant authorities in accordance with uniform principles, e.g. as set out in this document. Governments' rights to control ground-water abstraction and use as well as all activities with a potential impact on the quantity and quality of ground-water resources should be recognized by legislation.
2. Adequate definitions of ground-water characteristics, use and protection should be formulated and integrated into legislation with a view to avoiding ambiguities and thus facilitate implementation of legal provisions for ground-water management.
3. Ownership with respect to ground water should be clearly defined in a water act or code depending on national legislation. Ground water should be declared in the public domain or authority should be vested in Government to restrict, in the public interest, the rights accruing from its private ownership. New legislation should strive towards changing ownership rights into ground-water use rights subject to a government-controlled permit system. To this end, it would be necessary to draw up precise rules concerning the selection of criteria applicable for the recognition of ground-water use rights and for the granting of permits taking into account orders of priority for the allocation of available water. Such rules should also determine conditions of transfer, modification or abolition of use rights. Priorities to use ground water, however, should be kept flexible so as to satisfy present and future requirements such as socio-economic factors.

VI. COMPETENCE

1. Water authorities or co-ordinating bodies should have the competence to integrate all aspects of water management and should be rendered competent to arbitrate among the various competing demands, and diverging interests regarding ground-water abstraction and use, both short- and long-term. The authority or body should collaborate with other authorities, competent for public health, land-use planning, soils' management, waste management, etc. Legislation should provide administrative mechanisms for emergency cases and should empower the competent authorities to act immediately against damage.
2. The territorial competence of such authorities with respect to ground-water management should not necessarily be limited to either administrative boundaries or catchment areas but should allow for encompassing, as appropriate, management of aquifers in their entirety. The work of these authorities should be supported and facilitated by providing them with the resources necessary for the proper discharge of their functions.
3. Regulations, within the framework of legislation mentioned above, should define the actions to be taken by competent authorities in case of accidental pollution or other emergencies impacting on ground water.

VII. ECONOMIC MEASURES

1. Economic measures such as fees and waste-disposal charges should be applied in co-ordination and have sufficient impact to constitute an effective incentive to use ground water rationally or be a disincentive to polluting aquifers.
2. The abstraction of ground water could be subjected to differentiated fees in proportion to the volume abstracted, in relation to the available resource or according to the anticipated use of the abstracted ground water, while complying with legal provisions and regulations governing the applied permit system.
3. Costs attributable to pollution should be borne by the polluter whenever the latter can be identified. Serious consideration should be given to all possible economic measures which could have an influence on preventing, mitigating and counteracting damage as well as those bearing on remedying critical situations caused by pollution or over-exploitation of aquifers.

VIII. PERMIT AND PENALTY SYSTEM

An appropriate and effective permit and penalty system should be introduced and administered by the competent authorities. The system should promote preventive approaches inducing users to control any activity affecting the quantity and quality of ground water.

IX. EXPLORATION AND ABSTRACTION PERMITS

Permits for ground-water exploration or prospection should be granted by the responsible authority separately from those for ground-water abstraction or use because of the functional difference between the sinking of an exploration well and the large-scale exploitation of aquifers. Exploration permits should have short-term duration.

X. ABSTRACTION AND RECHARGE PERMITS

1. Abstraction of water from aquifers and the artificial recharge of ground water should be licensed and controlled by competent authorities according to specific requirements laid down in an appropriate permit system which should be flexible so as to adapt to site-specific conditions. The question of ground-water exploitability should be clarified on a case-by-case basis, taking into account all relevant aspects, including ecological ones. The relevant regulations should establish the extent to which exemptions can be allowed in cases of, for example, ground-water abstraction for households and systems for draining fields. Where compatible with national legislation, permits for ground-water abstraction and use as well as pollution control should not release the user of ground water from responsibility in case of detrimental effects on ground-water quality and quantity as a result of interventions covered by the permit granted.

2. Specifications of licences should include, *inter alia*, the purpose, amount, location, duration and technical characteristics of abstraction, as well as the legal status of the ground-water user.

3. Authorization for artificially recharging the aquifer should be granted only if the hydrogeological situation, environmental conditions and the recharge-water quality permit injection, percolation or infiltration of water by artificial means into aquifers for storage and retrieval of good-quality water as well as for restoring over-exploited ground-water resources. For induced recharge from adjacent streams or lakes, appropriate security measures should be applied to forestall accidental pollution.

4. Appropriate measures should be taken to combat salt-water encroachment into coastal aquifers. In such areas special regulations for ground-water abstraction should be enforced to avoid seepage into aquifers owing to over-pumping and the resultant lowering of the ground-water table.

XI. POLLUTION-CONTROL PERMITS

1. To prevent ground-water pollution, permits issued to regulate the discharge, disposal and possibly the storage of waste should specifically take into account the vulnerability of the aquifer concerned and the provisions necessary for its protection. These provisions should, in particular apply to production, handling, trading, transporting, storage and use of potentially hazardous substances especially those which are toxic, persistent and bioaccumulative and apply above all to:

- Effluents and sludges produced by waste-water treatment plants;
- Domestic-waste disposal sites;
- Subsurface waste containment by deep-well injection or container storage as *ultima ratio*;
- Surface storage of wastes potentially hazardous by virtue of their chemical composition.

In permitting such activities, *inter alia*, the hydrogeological situation of the area should be taken into consideration. On this matter the opinion of qualified specialists should be sought in all above-mentioned cases. Continuous monitoring programmes should be set up both to control water quality in aquifers as well as for checking compliance with permits granted. The specific regulations on nuclear plants and the handling and processing of radioactive substances should include appropriate provisions for the protection of underground waters.

2. Siting of controlled waste disposal should assure that there is no immediate and/or long-term hazard to ground water. Controlled sites should be equipped with protective installations according to the best available technology and monitored by competent authorities. Regulations or

guidelines should be drawn up for the site selection of controlled waste-disposal sites, their operation, monitoring, shut-down and eventual rehabilitation, with particular emphasis on ground-water quality protection. Solid or liquid wastes which are toxic, persistent, bioaccumulative or radioactive and which put ground water at risk should be subject to special treatment. Legislation should ban dumping of solid or liquid wastes at unauthorized sites.

3. When applying and operating pollution-control technology for cleaning gases, liquids or solids, during or after treatment processes, the pollutants concentrated in sludges, slurries, gases or solids should not be released uncontrolled into the environment and nor ultimately reach and pollute aquifers. Care should be taken so that pollutants separated from exhaust gas, flue gas and other gaseous emissions do not enter ground water. Measures should be taken to prevent pollution by volatile organic compounds and other aerosols.

4. Pollution control at the source should cover, in particular, those pollutants which are toxic, persistent and bioaccumulative. To this end, regulatory measures and economic incentives should encourage the replacement of chemicals hazardous to ground water by less harmful substances in industrial production processes. Similarly, regulations governing contaminants could be enforced with regard to trade, processing and transport of hazardous substances, with a view to averting or minimizing the risks of leakage into aquifers, and preventing accidental spills of hazardous substances.

5. Application of treated waste water and resulting sludge on land should be subject to licence and/or conform to nationally agreed codes of practice and be restricted to areas where there is no immediate or long-term hazard to ground-water quality. In this respect, particular care should be taken not to overload the self-purification capacity of the

soil filter and corresponding natural processes therein. Special attention should be paid to hazardous substances, for example heavy metals.

6. In principle, injection of liquid wastes into the ground should be prohibited. Deep-well injection of liquid wastes of industrial origin and other water of objectionable quality into the ground should be authorized only case-by-case as *ultima ratio*, if the necessary precautions and controls for deep-well disposal can be specified, and if injected wastes cannot harm nearby aquifers. Control methods should include proper siting, design, construction, operation, abandonment and monitoring of deep-well injection. Control measures should be taken to prevent wastes escaping into freshwater aquifers. Continuous hydrogeological surveys should be carried out in the planning stage and during construction. These should serve as a basis for authorization. Permits should specify, *inter alia*, restrictions on the operation programme, emergency procedures in the event of malfunction, as well as monitoring and abandonment procedures for deep wells.

XII. WELLS AND BOREHOLES

Drilling and sinking of wells and boreholes should as a rule be carried out by qualified and properly skilled personnel and with appropriate equipment. Prior notice should be given to competent authorities for drilling, sinking, constructing, enlarging, altering, sealing and repairing wells or boreholes and, once work is terminated, a report on the work accomplished should be filed. Provisions might be made for exemptions following precise rules in the case of small and shallow wells. Systematic control should be carried out over the technical status of operation, exploring and monitoring wells, in order to prevent the intrusion into aquifers of polluting substances from the land surface and the mixing of various water layers through drilling of wells.

XIII. MONITORING AND CONTROL

1. Monitoring programmes for ground-water protection should be set up and applied. These programmes should include monitoring at the source of potential pollution which could pose a serious or chronic threat to an aquifer. There should be regular inspections to ensure compliance with protection requirements imposed. Attention should also be paid to the monitoring of ground-water quality changes brought about by air-borne pollution.
2. Systematic monitoring should be carried out for all aquifers found to be vulnerable to pollution and/or over-use, as well as for those whose particular importance has been recognized for public water supply, mineral water supply and industry.
3. Monitoring and control should be considered a public-service activity. Facilities should be set up for co-ordinating the assessment and availability of monitoring data and information on aquifers. The resulting collections of data should be related to information on ground-water quantity and quality characteristics of aquifers as well as details of their location, use, and exposure to various impacts from land uses such as agriculture, industry and urban development. Information should be readily available to those interested.
4. The data from monitoring should make it possible, *inter alia*, to revise periodically plans and forecasts of ground-water use, taking into account actual evolution of aquifers, and to determine measures necessary to ensure the sustainable use of ground-water resources in the long term. Legislative provisions and regulations should, as appropriate, allow for the revision of protection requirements imposed depending on the measures thus determined.
5. Monitoring programmes should be periodically reviewed to ensure that they are achieving their stated aims and that the results have been used effectively.

XIV. IMPACT ASSESSMENT

1. All projects in any economic sector expected to affect aquifers adversely should be subject to an assessment procedure aiming at evaluating the project's possible impact on the water régime and/or the quality of ground-water resources, with particular attention to the important role ground water plays in the ecological system. Impact assessment surveys should continue during the construction and operation phases of a project, in order to keep under review any adverse impacts on ground-water resources before, during and after human interventions.
2. Impact assessments should be undertaken at an early stage of project planning and should be systematically applied to the different alternatives considered in a project study. Results of impact assessment procedures should duly be taken into account in decision making. Systematic monitoring of project realization by competent authorities should ensure compliance with conditions of ground-water protection.

XV. INVENTORIES

Inventories of all ground-water aquifers should be made, including data on their quantitative and qualitative characteristics, and their vulnerability to over-exploitation and pollution. The evaluation should include data on the present situation and future prospects with regard to aquifer use.

XVI. PLANNING AND FORECASTING

1. Special attention should be accorded to the application of planning tools and forecasting methods when managing ground waters and protecting aquifers against pollution and over-use. Programmes for continuous assessment of both the quality and quantity of ground water should be implemented, particularly for those aquifers vulnerable to or threatened by pollution or over-exploitation.
2. In the planning procedures, prospective studies and forecasts - both in terms of water quantity and quality - of future ground-water demands, use, consumption, discharge and environmental stress should not only be an extrapolation of past trends but should also take into account the anticipated effect of applied or foreseen control measures, economic incentives and other managerial instruments for ground-water protection. Objectives of planning, and in particular long-term planning, should not only serve the purpose of exploitation and utilization of ground-water resources but - to an increasing extent - should serve their protection. Planning should among other elements seek to include quality-forecasts of ground-water resources for appropriate time horizons, taking into account potential pollutants already in the ground and which would eventually contaminate ground water long after strict pollution-control measures had become effective.
3. Ground-water models should be built so that multi-variant/multiple forecasts can be made of the ground-water régime, particularly for aquifers at risk.

XVII. LAND-USE POLICIES

1. Land-use policies should take duly into account the exigencies of natural recharge and protection of ground water against pollution and over-exploitation. Co-ordination between the various responsible authorities should be promoted. The general application of land-use plans, where appropriate, can be an effective measure in this connection.
2. A co-ordinated approach to ground-water management and land-use control may call for negotiation procedures. Land-use policies should be co-ordinated with other relevant policies of integrated water management such as surface-water and ground-water management policies. Water managers should be involved in land-use planning already at an early stage of development processes. In areas where aquifers are unique, endangered or already impaired, ground-water protection strategies should carry decisive weight in land-use planning and control.
3. Aquifers should be designated critical when already heavily endangered or impaired by pollution or over-use. To avoid further degradation and to make possible their restoration, appropriate measures should be taken which could include changes in land-use patterns and related rights.
4. Sites of waste disposal and places where activities may result in contamination of land should be appropriately restored.
5. Increased attention should be paid to enhancing natural recharge of aquifers.

XVIII. PROTECTION ZONES

1. Where compatible with national legislation, ground-water protection zones should be established over and above the general protection of ground waters through relevant legal provisions, as a preventive measure protecting aquifers around present and future abstraction sites and in recharge areas where aquifers are vulnerable. Compliance with the prescribed restrictions should be strictly controlled.
2. Protection zones could be divided into different classes with differentiated restrictions on land-use and water-use graduated according to environmental considerations and the relative importance of the underlying aquifer. In this respect, particular consideration should be given to the establishment of well-head protection areas. Necessary measures should be taken to minimize the risks of accidental or diffuse pollution in protection zones.
3. Restrictions and/or prohibitions on land-use activities should include mining and industrial processes, manufacturing, intensive farming, including the application of fertilizers and pesticides on agricultural land, transportation, waste disposal and treatment as well as storage of dangerous substances.

XIX. POLLUTION FROM AGRICULTURE

1. Advice, recommendations, codes of good agricultural practice, legislation, regulations or economic measures should be applied to keep under control the widespread use of fertilizers and any chemicals in agriculture having potential effects on ground water. Policies applied through such measures should take into account the general diffuse nature of such pollution as well as the often considerable time-lag in the transfer of polluting substances to aquifers. These policies should, therefore, promote the application of preventive measures. To that end, all appropriate measures mentioned above should also be implemented to encourage and to promote the rational application of industrial fertilizers, manures, crop-protection products and pesticides. Restrictive measures with penalties for non-compliance should be adopted in particular for the protection of vulnerable aquifers and for protection zones.
2. In order to promote the rational use of agricultural inputs, appropriate measures or a combination of them should be taken, wherever deemed necessary, e.g. the establishment of contractual arrangements between professional agricultural organizations and water authorities; restrictive measures of a legal, regulatory or economic character taking into account socio-economic constraints and environmental conditions prevailing in each country or region.
3. Appropriate measures for controlled use of manure could be, for instance: limiting the operation of intensive large-scale livestock farming to sites where sufficient land is available for correct application and use of manure and slurry; making available large tracts of arable land through co-operative agreement between crop-farmers and livestock farmers, if necessary transporting manure over longer distances to croplands. If in a particular region manure is produced in excess of that needed for plant growth,

transport to regions which are deficient should be considered as a solution (manure banks). Conditioning of wastes for stabilization and sale as well as treatment of manure with recuperation of by-products (fertilizers) could also be considered. Manure-application control measures may also include: regulations including dosage and timing; volume increase of manure storage tanks; designing and using better equipment for manure spraying.

4. Strict licensing procedures should be introduced for the manufacture and distribution of crop-protection products and pesticides. Their use and application, however, is difficult to regulate. Recommendations should nevertheless be made with regard to their dosage, conditions of use, periodicity of application, precautions to be taken, etc. This advice may be included in information campaigns for farmers.

XX. POLLUTION FROM URBAN AND INDUSTRIAL SOURCES

1. Measures should be taken to control pollution associated with surface run-off from paved impermeable areas (e.g. streets) and with leakage from industry, transport, sewerage systems and treatment plants. Polluted surface run-off should be properly treated especially where vulnerable aquifers could be affected.

2. Sites of unauthorized waste disposal and other contaminated areas should be identified and adequately restored.

3. Leakage and spillage of contaminants from industries, transport, sewerage systems and waste-water treatment plants should be prevented through appropriate design as well as efficient maintenance and supervision including leakage tests. Detection of leakage from pipelines, storage tanks and other industrial facilities should be improved by appropriate inspection procedures.

XXI. CONTROL OF MINING ACTIVITIES

1. Dewatering of mines should be kept under control so as to minimize the adverse effects on the water régime, prevent depletion or pollution of nearby aquifers and infiltration of low-quality water. Special attention should be paid to the disposal of mining wastes so that they do not put at risk the quality of ground water. When mines are closed down they should be properly sealed off parallel to the abandoned wells and waste dumps. Vegetation on them should be re-established.

2. In planning and operating *in situ* conversion of coal into natural gas or fluids, strict safety measures should be designed and applied to avoid ground-water pollution induced by processing gases or liquids. This should be done in order to prevent leaching of minerals from reaction zones after mining, or to bar solvents, sulphur and phenol-rich fluids from reaching the ground water. Sites of any kind of waste, in particular tailings ponds for wastes from oil-sand and oil-shale extraction, as well as coal and metal mining should be sealed off against their contaminating ground water.

XXII. HEAT PUMPS

Water authorities should specify criteria for the location, operation, maintenance and closing down of heat pumps and other installations likely to use significant quantities of substances with potential to pollute ground water, e.g. dielectrics, and should draw up guidelines on related ground-water protection measures. Specific requirements should be set for a cooling agent and other chemicals used. Further restriction or even prohibition may be necessary in ground-water protection zones.

XXIII. RESEARCH

Research programmes should be intensified in order to improve knowledge of:

- (a) hydrodynamics in aquifers;
- (b) transportation, fixation and leaching processes of pollutants as well as cumulative phenomena of chemical compounds in the subsoil, in both saturated and unsaturated zones and even in deep-lying aquifers;
- (c) appropriate technical measures which prevent, or at least reduce substantially, the transfer of undesirable substances from human activities into ground waters and/or related surface waters;
- (d) elaboration of guidelines and technologies with regard to the prevention of ground-water pollution from agriculture;
- (e) economical and effective clean-up methods for polluted soils and aquifers; and
- (f) development and calibration of representative ground-water models. International co-operation aiming at the exchange of experience and views and/or joint or co-ordinated research programmes in these fields should be encouraged.

XXIV. EDUCATION AND INFORMATION

1. Education and information should promote greater awareness of the inherent ground-water problems at all levels, contributing to efficient implementation of the measures taken.
2. Every effort should be made to raise the level of knowledge of the public, in general, and of water users, in particular, as regards the nature, behaviour and vulnerability of ground-water resources. To this end, public information, education and training programmes should be encouraged.
3. Active participation of all parties concerned with the management and use of ground water should be promoted, with a view, *inter alia*, to achieving public acceptance of legal and administrative measures which could restrict the freedom of individual water users, in order to avert possible hazards in the case of misuse. Such knowledge should forestall resistance or outright opposition to the implementation of sound policies for ground-water management.

XXV. INTERNATIONAL CO-OPERATION

1. Concerted endeavours to strengthen international co-operation for harmonious development, equitable use and joint conservation of ground-water resources located beneath national boundaries should be intensified. To this end, existing or new bilateral or multilateral agreements or other legally binding arrangements should be supplemented, if necessary, or concluded in order to place on a firmer basis co-operative efforts among countries for the protection of those ground-water resources which can be affected by neighbouring countries through exploitation or pollution. In order to implement such co-operation, joint commissions or other intergovernmental bodies should be established. The work of other international organizations, particularly on data harmonization, should be taken into account.
2. Co-operative arrangements could include: data collection, standardization and exchange; establishment of joint inventories; research and training; planning and demand-management; joint control and monitoring of activities with regard to quantitative and qualitative aspects of ground-water protection; elaboration of compatible monitoring methods, standards and permits; establishment of adjacent protection zones; establishment of commonly agreed land-use plans and practices; monitoring of surface- and ground-water resources' behaviour and interdependence; and the obligation to give notification concerning any activity which might modify the volume and/or the quality of ground water.