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Implementation of the European Union's Nitrates Directive in Turkey

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ABSTRACT

The European Union (EU)'s Nitrates Directive (ND) (91/676/EEC) aims to reduce water pollution caused or induced by nitrates from agricultural sources and to prevent further such pollution. Turkey being a candidate country to EU requires heavy cost investments in achieving approximation with EU Environmental Acquis. This study provides a description of the technical measures and investment cost assessment related to the implementation of the ND in Turkey. As Turkey has not yet designated nitrate vulnerable zones (NVZs) according to requirements of the EU's ND, three scenarios were developed to estimate the capital investments needed for implementation of the ND. Based on the developed scenarios, the low-cost scenario designating eight provinces as NVZs and requiring a total investment of EUR 270 millions for the period 2007–2023 has been selected by the Ministry of Environment and Forestry within the EU Integrated Environmental Approximation Strategy for Turkey.

Keywords: EU Nitrates Directive; Nitrate vulnerable zones; Turkey

1. Introduction

In April 1987, Turkey submitted its application for becoming a member of the European Community. The Commission adopted its opinion on the application in December 1989. In December 1997, the Luxembourg European Council confirmed at the highest level "Turkey's eligibility for accession to the European Union (EU)". The Accession Partnership, which is a roadmap of the priorities for Turkey in making progress towards meeting all the criteria for accession to the EU, was formally adopted by the EU Council on 8 March 2001. In December 2004, the European Council decided to start negotiations in October 2005 with the Government of Turkey with the aim to achieve full membership of the EU for Turkey. Based on the Accession Partnership the Turkish Government adopted its National Program for the Adoption of the Acquis

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(NPAA) in March 2001. A revised NPAA was adopted in 2003. This document outlines how Turkey envisages dealing with the Accession Partnership, the timetable for implementing the Partnership's priorities, and the implications in terms of human and financial resources.

According to the 2006 Regular Report on Turkey's Progress toward Accession, the country has made progress in transposing the Environmental Acquis in some areas, including water quality. Regarding the Nitrates Directive (ND) (91/676/EEC), transposition was achieved through the adoption of the By-law on the Protection of Waters against Pollution caused by Nitrates from Agricultural Sources in 2004. According to the report, further efforts, especially related to implementation and enforcement, are needed particularly in the areas of horizontal legislation, air quality, waste management, water quality, nature protection, industrial pollution, and risk management. It is stressed as well that considerable investments need to be secured, also in the medium term.

1.1. Requirements of the directive

The objectives of the ND are twofold: firstly, to reduce water pollution caused or induced by nitrates from agricultural sources, and secondly, to prevent nitrates pollution in the future. The ND seeks to ensure that the objectives are met by requiring that Member States identify waters affected by pollution and waters that could be affected by pollution and that they designate these areas as "vulnerable zones" based on the results of the monitoring requirements in the ND. In these zones, the Member States must draw up action programs that contain mandatory measures concerning agricultural practices, including stipulation of the maximum amount of manure that can be applied to land every year. Member States are also bound to establish at least one code of good agricultural practice which is implemented on a voluntary basis outside the vulnerable zones, and is mandatory within them. Member States are obliged to monitor the nitrate concentration of waters to assess the impacts of the measures put in place.

The Directive requires three types of monitoring:

(1) Water monitoring for the identification of waters under threat (Article 3.1): Waters affected by pollution and waters which could be affected by pollution if action is not taken:

- Surface waters (nitrate concentration);
- Groundwaters (nitrate concentration);
- Freshwater lakes, other freshwater bodies, estuaries, coastal waters and marine waters (eutrophication).

(2) Water monitoring for the designation of vulnerable zones (Article 6.1):

- within two years of notification of the Directive, monitor the nitrate concentration in freshwaters over a period of one year;
- repeat the monitoring program at least every four years, except for those sampling stations where the nitrate concentration in all previous samples has been below 25 mg/l and no new factor likely to increase the nitrate content has appeared, in which case the monitoring program need to be repeated only every eight years;
- review the eutrophic state of fresh surface waters, estuarial and coastal waters every four years.

(3) Monitoring connected with the evaluation of the effectiveness of the action programs (Article 5.6).

It is a requirement of the Directive that Member States monitor the effectiveness of the measures implemented to reduce nitrate pollution. This means not only monitoring to assess the level of nitrate pollution in order that new designations can be made, or existing designations reviewed, but also the effectiveness of the agricultural regime put into place.

1.2. Implementation steps

The implementation of the ND consists of five steps (following its transposition in each Member State) [1]. These steps are as follows:

- Step 1: Detection of polluted or threatened waters (N) (1-year monitoring):

(a) Human Health Protection;
(b) Living resources and aquatic ecosystems protection;
(c) Eutrophication prevention.

- Step 2: Designation of "Nitrate Vulnerable Zones" (NVZs):

(a) Areas of agricultural land with significant contribution to N pollution at watershed level.

- Step 3: Code(s) of good agricultural practice (on all Member State Territory–Voluntary)
- Step 4: Action Programs within NVZs:

(a) Code(s) of good agricultural practice becomes mandatory;
(b) Other measures (nutrient balance, manure storage, spreading <170 kg N organic/hectare/year).

- Step 5: National monitoring (200–2,000 points/Member State) and reporting:

(a) Every four years on NO_3 concentrations and eutrophication (algae);
(b) Assessment of Action Programs' impact;
(c) Revision of NVZs and Action Programs.

To limit the losses inflicted on the agricultural sector, the main types of actions that the ND promotes cover: crop rotations, soil winter cover, catch crops, in order to limit leaching during the wet seasons, use of fertilizers and manure, with a balance between crop needs, N inputs and soil supply, frequent manure and soil analysis, mandatory fertilization plans and general limitations per crop for both mineral and organic N fertilization; appropriate N spreading calendars and sufficient manure storage available only when the crop needs nutrients, and good spreading practices; "buffer" effect of non-fertilized grass strips and hedges along water courses and ditches; good management and restriction of cultivation on steeply sloping soils, and of irrigation. The objective of this study is to assess the legal, administrative and technical measures needed and to evaluate the costs required for the adaptation of the EU's ND in Turkey.

2. Background of the study

2.1. Climatic conditions and agricultural regions in Turkey

Despite its large area (78 million hectares), Turkey is not rich in cultivable land. Of the total land, almost one-third or 27.7 million hectares can be classified as cultivable, and according to recent studies, 8.5 million hectares can be estimated as irrigable. Influenced by climate, plant cover, topography and the parent bedrock, the soils in Turkey show very large differences in their chemical, physical and biological properties and fertility [2]. Turkey is geographically situated in the Mediterranean area where climatic conditions are quite temperate, however, due to the diverse nature of the landscape, and the existence in particular of mountains that run parallel to the coasts there are significant differences in climatic conditions from one region to the other. While the coastal areas enjoy milder climates, the inland Anatolian plateau experiences extremes of hot summers and cold winters with limited rainfall. The Aegean and Mediterranean coasts have cool, rainy winters and hot, moderately dry summers. Turkey's diverse regions have different climates because of irregular topography.

Turkey is characterized by an extreme geo-climatic diversity, which permits the production of a wide range of livestock and crops. There are several publications concerning the climatic zones of Turkey. Depending on the method used, up to 22 agro-ecological zones and several sub zones have been identified. For practical reasons and to reflect the similarities of pastoral and animal husbandry systems, the classification developed by Turkish Statistics Institute (TURKSTAT) and the Ministry of Agriculture and Rural Affairs (MARA) was used in this study. The TURKSTAT recognizes nine agricultural regions in Turkey (Fig. 1).

2.2. The agricultural sector in Turkey

In terms of employment, agriculture is the most important sector in the Turkish economy. Its contribution to the total GDP makes it also one of the most important sectors. Since 1980, however, the share of agriculture in GDP has declined from 23.9 to 10.1% in 2000 and to 8.3% in 2009. Despite the decreasing share in GDP, agricultural production has been rising since 2000. The share of agricultural export in total exports was 6.1% in 2000 and 4.4% in 2009, and the share of agricultural import in total imports was 3.9% in 2000 and 3.3% in 2009. The share of agricultural employment within total employment was 36% in 2000 and 24.6% in 2009 [3]. While the importance of agriculture within the national income decreases, a great part of the population is still earning its living from agriculture [4].

Agricultural production in Turkey is highly diversified due to the wide range of climatic and topographical conditions. Using world prices to calculate the value of output quantities, Food and Agriculture Organization [5] reports that in 2003, Turkey's top commodity was wheat, followed by cow milk, tomatoes, grapes and cotton lint. Other important commodities are barley, indigenous cattle and chicken meat, olives, and apples. By international standards, Turkey is a major agricultural producer. Turkey ranks in the top five of world producers for chickpeas, chilies, and peppers, cotton, cucumber, eggplants, green beans, lentils, nuts (hazelnuts, pistachios, chestnuts, walnuts), onion, sugar beet, tomatoes, watermelons and melons, stone

Fig. 1. Agricultural regions in Turkey.

fruit, figs, olives, and sheep milk. Turkey is the world's largest producer of apricots, hazelnuts, and figs [5].

Agricultural production in Turkey has a distinctive regional distribution based on geographic and climate factors. Most of the agricultural production originates from the coastal regions, with the highest production in the Mediterranean and Aegean regions, which are highly suited to fruit and vegetable production [6]. According to the General Agricultural Census of the year 2001, there are approximately three million agricultural holdings in the country. Only around 2.4% of these holdings deal with husbandry and 67.4% with crop production along with livestock. The rest 30.2% deals only with crop production. Regional distribution of agricultural holdings shows that most of the farms are in the Black Sea and Aegean regions. However, the Central North and South East regions have the largest agricultural land area. More than 50% of agricultural holdings in Turkey operate on small farms with less than 10 ha. The Central South Region appears to have larger farms than the other regions while the Black Sea region is dominated by relatively small farms.

2.2.1. Crop production

Crop production preserves its importance within the agricultural sector production with a share of 65%. However, as the crop production potential, which is largely dependent on climate conditions, could not be utilized at an adequate level, productivity remained low. The crop production in the period from 1980 to 2000 is presented in Table 1.

Turkey is among the world's most important producers of horticulture with a production reaching 41 million tones in the last few years. Turkey has a share of 3.2% in the world vegetable production and is among the leading countries in vegetable production. Soft-seeded fruits account for 22% of the total fruit production, whereas rigid-seeded fruits account for 25%, citrus fruits for 16.5%, and grapy fruits for 31% of the total production.

2.2.2. Livestock production

The livestock sector has a great importance for Turkey, not only because of the need in animal products, but also because it creates constant employment and provides raw material for the meat, milk, feeds silk, and woolen textile, and leather industries. Although the number of livestock in the country is much higher than in most countries having a rather developed livestock sector, productivity per animal is considerably low. Livestock numbers in Turkey are given in Table 2.

2.2.3. Irrigation development

According to the Eighth Five Year Development Plan (FYDP) of Turkey [8], 4.9 million hectares of cropped area of Turkey are irrigated, while the rest is rain fed (22.5 million hectares). During the decade 1980–1990, Turkey spent 30% of the total agricultural sector investments on major irrigation investments. The reason for devoting such substantial resources to irrigation lies mainly in the nature of existing ecological conditions and the potential gains in the production and employment, which can be realized in irrigated agriculture. In the Eighth FYDP [8], it was envisaged that a new irrigation network will be

Table 1
Crop production in Turkey 1980–2000 (in 1,000 tones) [7]

Crop type	1980	1996	1997	1998	1999	2000
Industrial crops	7,583	15,603	19,577	23,498	18,215	19,901
Peas and beans	818	1,832	1,700	1,600	1,360	1,316
Cereal crop	24,063	29,188	29,610	33,031	28,724	32,084
Oilseed plants	1,654	2,166	2,255	2,407	2,309	2,243
Fodder crops		5,385	5,068	5,319	5,192	5,373
Globular crops	4,040	6,930	7,285	7,600	8,586	7,651
Vegetables	11,990	20,216	18,785	21,152	22,083	22,238

Table 2
Total number of livestock and its distribution based on different types and farms sizes [7]

Livestock	Number of farms	Land area, hectare	Average land area/farm, hectare	Number of animals/farm	Total number of animals
Calf	1,529,981	9,929,211	6.5	2	3,719,954
Hen	807,297	5,635,602	7.0	46	37,055,063
Sheep	392,742	3,582,756	9.1	34	13,229,515
Lamb	276,765	2,561,909	9.3	19	5,315,955
Cattle (total)	1,738,249	10,998,192	6.3	6	9,838,348
Cow (milk)	1,695,842	10,767,677	6.3	3	4,972,997
Goat	241,127	1,426,428	5.9	26	6,211,401

installed on a total of 475,000 hectares, and in order to obtain maximum benefit from irrigation, on-farm development activities will be accelerated and extended to 310,000 hectares.

2.2.4. Use of fertilizers and manure

According to the European Environmental Agency [9], fertilizer use remains relatively low in Turkey, at levels similar to central and eastern European countries. In the mid-1990s, nitrogen and phosphate use per hectare of arable land and permanent cropland was among the lowest within the OECD countries [10]. Fertilizer use is unevenly distributed across regions, with higher levels in the Aegean and Mediterranean regions, the latter using an average of 128 kg per ha. Pollution is not exclusive to those areas with high input use. In some irrigation schemes, drained water is re-used or flows to marshes, causing impacts on wildlife [11]. In some zones, run-off, drainage, and deep percolated water from irrigated lands contain high levels of fertilizer and pesticide residues. In addition to chemical fertilizers, all kind of manure is used in agriculture. In a large part of the country (Eastern, South Eastern and Central Anatolia regions), livestock manure is used by the rural population for heating in wintertime (burning) as well.

2.3. National legal framework

The "By-law on the Protection of Waters against Pollution Caused by Nitrates from Agricultural Sources" is the main legal document transposing the requirements of the ND in relevant Turkish legislation. The provisions of this regulation are executed by the MARA and the Ministry of Environment and Forestry (MoEF). According to the RCNAS (Article 6), NVZs should be identified two years after the publication of the regulation according to the below criteria:

- All surface and groundwater used or could be used in the future as drinking water contain nitrate above a level of 50 mg/L or could contain if the measures described in the Regulation (Article 8) are not taken;
- Whether natural freshwater lakes, other freshwater resources, bays, coastal waters and seawaters are eutrophic or not, and whether these waters could be eutrophic if the measures cited in the regulation (Article 8) are not taken.

Table 3
Institutional responsibilities and deadlines for the implementation of the ND

Issue	Reference	Responsible institution
Determination of nitrate pollution	Article 5	MARA, MoEF, MoH, MoENR
Code of good agricultural practices	Article 7	Related institutions under the coordination of MARA
Establishment of action programmes	Article 8	MARA
Revision of action programmes	Article 8	MARA
Implementation of action programmes	Article 9	MARA, farms
Monitoring programmes	Article 10	Established by MARA, monitoring by MARA, MoH, MoENR

Within two years after the publication of this regulation (in 2006) it is required that a general level of protection against pollution in all waters is ensured. Good agricultural practices must be developed by related institutions under the coordination of the MARA. The regulation requires that action programs be reviewed and, if necessary, revised, including additional measures every four years. According to the Regulation, the MARA must establish monitoring programs, which assess the effectiveness of action programs. The nitrate content of both groundwater and surface water at selected measuring points must be monitored by the MARA, the Ministry of Health (MoH), and the Ministry of Energy and Natural Resources (MoENR), the MARA being responsible for the coordination. The responsibilities of the different institutions for implementation of the ND are summarized in Table 3.

3. Results and discussion

3.1. Implementation measures

3.1.1. Legal and administrative measures

The ND encourages the MoEF and MARA to collaborate in identifying waters vulnerable to nitrate pollution and in reducing inputs of nitrate by controlling fertilizer usage and manure spreading. The MoH could also be involved regarding issues relating to the pollution of drinking water.

The relationship with the Urban Waste Water Treatment Directive (UWWTD) (91/271/EEC) is an important consideration as the designation of "sensitive areas" under that Directive applies similar criteria and requires action plans that may have an impact on action taken under this Directive. Surface water and groundwater areas must be designated as vulnerable zones, if they contain or could contain more than 50 mg/L of nitrate. There are two options for the way in which the ND may be implemented. The ND requires that land which drains into waters that are affected by nitrate pollution be identified and receiving waters be designated as "vulnerable zones" and that action plans be formulated to improve the situation in each zone. Under Article 3 [4], however, a State may choose to apply an action plan to the whole of its territory. The first alternative requires extensive monitoring and investigation. The second option limits the amount of monitoring which must be undertaken in the first instance, but applies any agricultural changes that are required to the whole country.

In drawing up Action Plans, the possible role of non-agricultural sources of nitrates in causing an exceedance of the 50 mg/L limit for drinking waters or as a contribution to eutrophication, must be taken into account. The most likely source of non-agricultural nitrate is domestic sewage works. This is an important issue, if the decision has been taken to implement the Directive through the identification of individual zones. The implementation of the UWWTD may have a significant impact where nitrate removal is considered in wastewater treatment plants because the sewage effluent discharges into a sensitive area under the terms of that Directive. The relative contributions of nitrate from agriculture and sewage effluent are not always easy to determine. Ensuring that plans made under the ND take account of the plans to be implemented for the UWWTD should be a duty undertaken by the competent authority.

The competent authority, in collaboration with other relevant ministries and experts, should identify periods for each zone (or more generally) when application of fertilizers or manure must be prohibited (by reference to meteorological conditions, soil characteristics and farming practices). These should be made mandatory. The codes of good agricultural practice may refer to the use of fertilizers in terms of when and how they should be used, and the precautions to take to prevent run-off from land into watercourses which may occur during their application, particularly from land which is close to watercourses and direct run-off may occur under conditions such as steeply sloping land, or in very wet periods. Nitrate release from ploughing of land should also be discussed in the codes. The need for manure storage facilities should be covered. Such codes are voluntary but

Candidate Countries should consider what means are available to encourage their general adoption by farmers. Adequate training in the new techniques of farming is essential, and training programs should be a feature of the Action Plans. A means of judging the effectiveness of training should be set up.

It is important to involve the farming community in consultations about the action required by the Directive as the action plans may result in farmers having to alter the ways in which they have worked for many years, including changes to the cropping patterns, and how they deal with livestock and livestock wastes. The storage of manure during parts of the year may be required, and the construction of new storage facilities may be required. It is difficult to visit and inspect farms over a large area at frequent intervals; therefore, the cooperation of farmers in ensuring that they accept and incorporate the new methods into their everyday working practices is important. Consultation with farmers, their representative bodies and their Ministry is essential. Such consultation may be useful in resolving disputes where the boundaries of vulnerable zones cross individual farm boundaries and more than one farmer is involved in meeting the improvement criteria. Reporting to the Commission is specified in Article 10 and Appendix V of the Directive. The reports must be submitted every four years.

3.2. Technical measures

3.2.1. Manure storage facilities

The investment costs of implementation of the ND are related to limitations for land application of nitrogen compounds (including animal manure). Manure cannot be spread on frozen or water saturated land; therefore, appropriate storage facilities, enabling farmers to store the manure during these periods have to be installed. The volume of the storage facilities is to large extent determined by climatic conditions. The following heavy investment costs for implementation of the ND are identified:

(1) establishment of manure storage facilities on farms with livestock production;
(2) purchase of machinery for collecting, transferring, and spreading of manure on fields.

Animal manure for biogas production is used in EU countries as an option to get rid of excessive manure; however, these investments are very costly, and the feasibility has to be assessed on a case-by-case basis. Calculations based on available statistical data show that the estimated average load of nitrogen from livestock manure in Turkey is about 35 kg N/ha agricultural land. This is far below the limit of the ND; therefore, at the national level, there is a sufficient area of land for spreading of livestock manure. Installation of biogas units will not be considered in this study. There are very limited data on available manure storage facilities. Data provided by the MARA indicates that a typical medium and large farm includes manure storage facilities (usually hard floor manure pad without a tank for collection of urine and rain water run-off). However, the quality of many of these facilities is not high enough to avoid pollution by nitrates. Small farms (10 and less animals) usually do not possess any manure storage facilities, and manure is piled close to the barn.

3.2.2. Monitoring

Investment costs related for the monitoring program for the ND are related to:

- Investments in laboratory capacity;
- Establishment of sampling stations.

Investments in laboratory capacity should be assessed in the context of general institutional strengthening of environmental monitoring and enforcement authorities. Many of the EC Environmental Directives set requirements for monitoring and enforcement. Therefore, it is proposed to address this issue in a separate institutional strengthening project.

The monitoring network has to be representative and cover the entire national territory. Networks of sampling stations have to cover both all main groundwaters (even if not used for drinking water), rivers, lakes, coastal and marine waters, as required by the Article 6 of the Directive. Criteria to monitor are nitrogen (ammonia, total N, and nitrates) and eutrophication (chlorophyll, algal blooms, macrophytes development, species shift, etc.).

Generally, the investment costs for the establishment of sampling stations are determined by the costs of drilling of wells for groundwater monitoring, as the investment costs of establishing surface water monitoring stations are negligible. Although a few of them are currently operational, there are thousands of groundwater wells drilled by the State Hydraulic Works (SHW) in Turkey. It was decided by the working group that, these wells can be used for monitoring purposes; hence, there is no need to drill groundwater wells to establish monitoring stations. Currently, there are more than 715 groundwater stations monitoring

nitrate, of which 115 are operated by the SHW and more than 600 by the MARA.

When designing the groundwater monitoring program, it is recommended to take into account the requirements of the Water Framework Directive (WFD), as part of the established monitoring wells may serve the purposes of the WFD.

3.3. Cost assessment

3.3.1. Measures covered by the cost assessment

The investment costs of implementing the ND are related to limitations for land application of nitrogen compounds. To reduce run-off of nutrients and contamination of waters by nitrogen compounds, action programs should define the periods when livestock manure cannot be applied on the fields (periods when land is frozen or saturated with water). The farms with livestock production will therefore need to establish facilities to store the livestock manure during the above-mentioned periods. The types of costs incurred in the implementation of the ND are [13]:

(1) Initial set-up costs

- Establishment of competent authority;
- laboratory capacity;
- initial sampling program and analysis;
- data interpretation of the first survey;
- consultation with farmers;
- designation of vulnerable zones and preparation of action programs;
- preparation and publication of codes of good agricultural practices.

(2) Capital expenditure

- Construction of manure storage facilities.

(3) On-going costs

- Changes in farming practices;
- follow-up surveys at four-year interval;
- designation of additional vulnerable zones (unless action programs cover whole territory);
- preparation of additional action programs.

The following heavy investment costs for the implementation of the ND have been assessed:

(1) Establishment of manure storage facilities in farms with livestock production;
(2) purchase of machinery for collection and spreading of manure on fields.

The farms will reap benefits due to savings for fertilization (gain in nutrients that are currently lost due to evaporation or leaching) and experience an improvement in soil quality. However, the benefits of the investments in manure storage facilities and spreading machinery were not estimated. Operation and maintenance costs of manure storage facilities are negligible, and therefore, these were not considered.

3.3.2. Approach and assumptions—manure storage facilities

The following approach was used to calculate the capital investment costs for the establishment of manure storage facilities:

(1) Based on statistical data obtained from the TURKSTAT, farms are divided into five size classes based on number of animals. For all livestock types, except of hens, the following classes are used: <10; 10–100; 100–500; 500–1,000; and >1,000. Farm size classes for hens are as follows: <1,000; 1,000–5,000; 5,000–10,000; 10,000–50,000; and >50,000;
(2) For each province, the costs of manure pad, urine tank, slurry reservoir, and manure transportation, and spreading machinery are calculated separately for each livestock type and farm size class. The calculations are based on amounts of manure and urine productions, which are calculated from the total number of animals and unit manure and urine productions. Rain water is also taken into consideration for urine tanks;
(3) Capital investment costs for three scenarios of NVZs (low cost, medium cost and maximum cost scenarios) were assessed.

The following assumptions were formulated for the definition of scenarios and calculation of investment costs for manure management:

(1) The volume of the manure storage facilities is determined by the climatic conditions, as manure spreading should not be permitted on frozen or water saturated land. The estimated duration of period when manure must be stored in storage facilities is provided in Fig. 2 below;
(2) The Eighth FYDP [8] foresees growth in cattle production and a decrease in sheep numbers

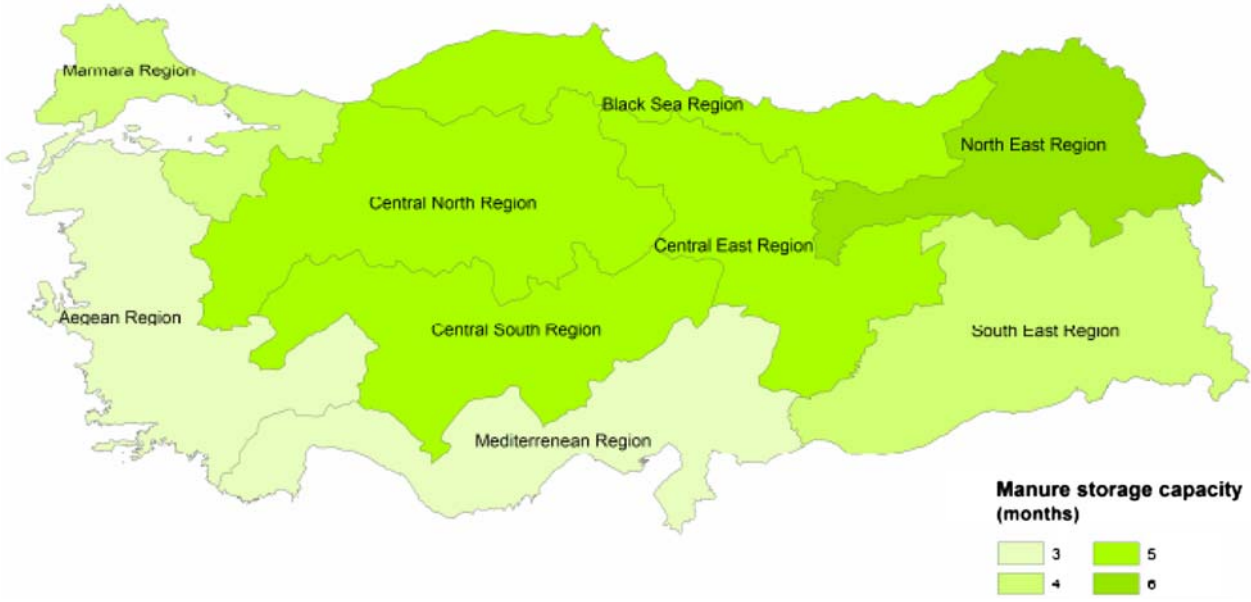

Fig. 2. Estimated duration of manure storage in the nine agricultural region.

between 2001 (data used for cost assessment) and the estimated date of accession (2014). However, the changes in animal numbers are less 10%, and therefore, taking into account other uncertainties of the assessment, it was assumed that the 2001 data of animals can be used without further modifications;

(3) For the assessment of investment costs in cattle farms with more than 100 animals per farm, the following was assumed (based on information received from the MARA);

- Approximately, 70% of cattle farms with more than 100 animals have manure storage facilities (hard floor manure pad by the barn), but reservoirs for collection of liquid manure and run-off water are absent. These farms need to install reservoirs for the collection of liquid manure (urine tank);
- Approximately, 30% of cattle farms with more than 100 animals do not have appropriate manure storage facilities. These farms need to install slurry reservoirs of an appropriate size (taking into account rainwater and technological water);

(4) For assessment of investment costs in other farms, the following was assumed:

- Manure pad together with urine tank have to be constructed on all small and medium-sized agricultural holdings with less than 100 cattle;
- Manure pad and urine tank have to be constructed on all farms with sheep, goat, and lamb production of more than 100 animals;
- No manure storage facilities are proposed for farms with less than 100 sheep, goat or lamb;
- A manure pad has to be constructed on all chicken farms with annual production of more than 5,000 hens.

3.3.3. Transportation and spreading machinery

Manure and slurry transportation and spreading machinery have to be purchased by cattle farms with more than 100 animals (based on expert knowledge and experience from other countries). For cattle farms with less than 100 animals class, having an average number of animals of more than 25, it is proposed that manure and slurry transportation and spreading machinery are shared. In order to calculate the required number of machinery for such farms, the total number of farms is divided by the result of 100 animals divided by the average number of animals in one farm. It was agreed with the MARA of Turkey that 100 animals are the limit for purchase of machinery.

3.3.4. Data sources and unit costs—manure storage facilities

Data on the distribution of livestock among the different farm size classes were provided by the TURKSTAT (based on the 2001 census of agriculture data). Additional data were obtained from the

TURKSTAT publications [7]. For this cost assessment, a flat unit price for the construction of manure storage facilities was used:

- Manure pad—EUR 45 per 1 m^2;
- Urine tank (to be constructed together with manure pad)—EUR 35 per 1 m^3 of storage capacity;
- Slurry reservoir—EUR 30 per 1 m^3 of storage capacity.

The unit costs were assessed by the experts and compared with the estimated need and prices of concrete.

3.4. Transportation and spreading machinery

Application of manure in fields is made by means of manure spreading equipment—a tractor-dragged slurry tanker with spreading system. The unit cost of the manure-spreading equipment (slurry tanker with a capacity of 18m^3) is EUR 42,500. It is interesting to note that most cattle farms belonging to the "less than 100 animals" class have an average number of heads less than 25. Therefore, according to the assumptions described earlier, there is no need to invest in spreading machinery in this class of farms. The biggest share of investment, therefore, will have to be made by the farm category having between 100 and 500 animals.

3.4.1. Investment costs related to manure management—three investment cost scenarios

Turkey has not yet designated NVZs according to requirements of the ND (Article 3). Consequently, the scenarios presented should be regarded as the preliminary attempts to estimate the capital investments needed for implementation of the ND.

The following was taken into account in developing the scenario for NVZs:

(1) Provinces with intensive agricultural and livestock production, in which pollution of waters by nitrates from agricultural sources may be expected;
(2) Eutrophication of inland water bodies, coastal and marine waters. Taking into account the environmental status and international obligations of Turkey (the Black Sea Action Plan prepared under the 1992 Bucharest Convention), special emphasis is put on the catchment area of the Black Sea.

It should be noted that statistical information on livestock production is available at province level; therefore, the territories in the scenarios presented below were adjusted to fit the province boundaries. Lists of provinces which should be designated as vulnerable under the minimum and medium cost scenarios were compiled following close collaboration with the MARA.

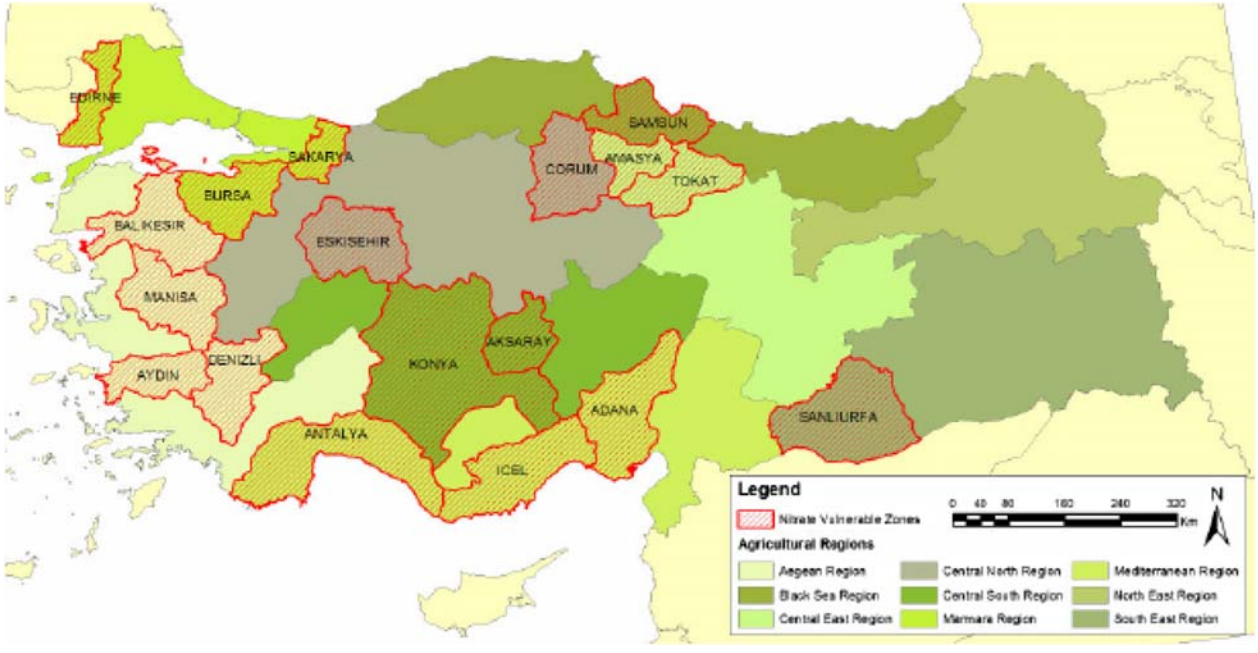

Fig. 3. Map of NVZs: low cost scenario.

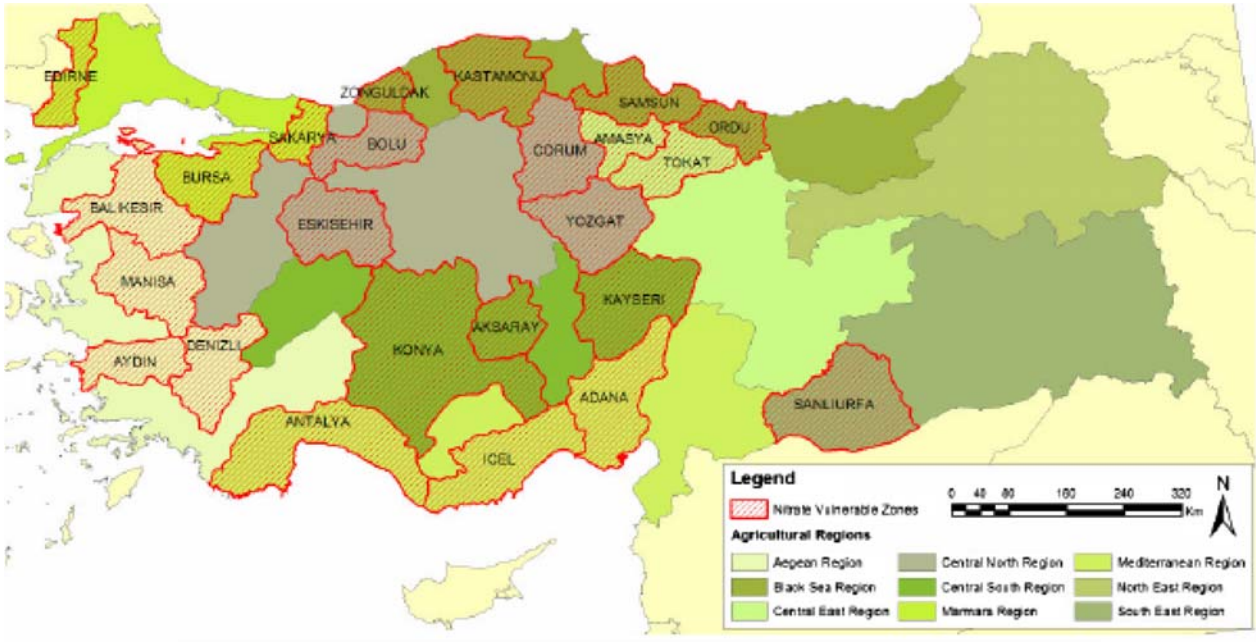

Fig. 4. Map of NVZs: medium cost scenario.

3.4.2. Low cost scenario—18 provinces as NVZ

According to the low-cost scenario, the NVZ comprises 18 provinces namely Adana, Aksaray, Amasya, Antalya, Aydın, Balıkesir, Bursa, Çorum, Denizli, Edirne, Eskisehir, Konya, Manisa, Mersin, Sakarya, Samsun, Tokat, and Urfa (Fig. 3).

The total investment costs in manure storage facilities under the low-cost scenario are in the order of EUR 255 million. The estimated additional capital investment cost in manure transportation and spreading equipment is approximately EUR 15 million.

3.4.3. Medium-cost scenario—24 provinces as NVZ

According to the medium-cost scenario, the NVZ includes the provinces under the low-cost scenario (18 provinces), plus six additional provinces, four of which are situated in the Black Sea region: Bolu, Kastamonu, Kayseri, Ordu, Yozgat, and Zonguldak. A map of the NVZs under the medium-cost scenario is presented in Fig. 4.

Total investment costs in manure storage facilities under the medium-cost scenario are in the order of EUR 367 million. The estimated additional capital investment cost of manure spreading equipment is approximately EUR 15 million.

3.4.4. Maximum cost scenario—whole country as vulnerable

The maximum-cost scenario should be regarded as a conservative scenario, and the calculated investment costs will indicate the maximum level of investments needed for the implementation of the ND. The total investment costs in manure storage facilities under the maximum-cost scenario are approximately EUR 978 million. Estimated additional capital investment costs in manure-spreading equipment equal approximately EUR 17 million.

4. Conclusions

In 2006, Turkey has published the EU Integrated Environmental Approximation Strategy [12], containing the information regarding the technical and institutional infrastructure, and the environmental improvements that are required to be performed as well as mandatory arrangements which are necessary to be established for complete harmonization and compliance with EU Environmental Acquis Communautaire.

The types of costs incurred in the implementation of the ND are [13] the following : initial set-up costs, capital expenditure, and on-going costs. In this study, the following heavy investment costs for the implementation of the ND have been assessed:

(1) Establishment of manure storage facilities in farms with livestock production;
(2) Purchase of machinery for collection and spreading of manure on fields.

Regarding compliance to the EU's ND, the MoEF has decided to choose the low cost scenario requiring a total investment of EUR 270 millions in the period

2007–2023. The investment plan has been arranged as EUR 15 millions for the years 2007 and 2008 and EUR 16 millions for the rest till 2023.

In EU Integrated Environmental Approximation Strategy [12] document, the goal regarding the Directive has been stated as "The pollution caused by agricultural nitrate in the water and the soil will be monitored, minimized and pollution will be prevented." For the realization of this goal, the sensitive areas according to the Directive will be defined until 2007. The strategies to be implemented to achieve this goal have been identified as:

- Implementation of good agricultural practices at the defined sensitive areas;
- Monitoring in the areas that are defined as sensitive and improvement of the soil and water quality in terms of nitrates.

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