

Water Discharges into the Bulgarian Black Sea

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Abstract

In respect to marine pollution, the Black Sea is one of the world's most vulnerable areas as it refers to the internal continental seas, with limited contact to the World Ocean. Human activity has affected the Black Sea environment and its shores. The survey highlights the factors and issues related to pollution of the Bulgarian Black Sea by various discharges, and address it since if not be resolved, this marine environmental problem can become security threat. The aim is to analyze the current environmental setting related to discharges into the Bulgarian Black Sea and to focus on the most critical problems as to pollution. The survey ranges over a large number of discharges by rivers, municipal and industrial sources, agriculture, etc., linking to pollution of the Bulgarian Black Sea. Current environmental state is due to ineffectiveness in discharge control, management and necessary infrastructure.

Keywords

Discharges, pollution, water environment impacts, the Black Sea

INTRODUCTION

Though almost enclosed, the Black Sea is deep (EC, 2011). The maximum depth in the central part is 2210 m. With regard to oxygen, the water is an extremely vulnerable environment. For the past thirty years, the major rivers that flow into the Black Sea have been dumping massive quantities of industrial waste into it, resulting in considerable damage to the ecosystem. The Black Sea is still the most popular tourist destination for people in nearby countries. Significant is the large volume of traffic passing through the area – both people and goods, including gas and oil on its way from the Caspian Sea - mostly transported on tankers. Major construction work is currently underway on pipelines.

Co-operation is necessary between national authorities, responsible for water management, with a view to improving their ability to deal with challenges arising in a shared basin. Typical concerns include floods, drainages, construction and hydroelectric power plants, shipping and fishery. Water pollution is also an issue, with specific purpose of reducing the amount of pollution, discharged into the sea and protect water environment. However, although legislation on pollution exist, it is often not enforced.

MATERIAL

Quantitative data regarding discharges and pollution loads on the Bulgarian Black Sea (Figure 1) from several sources were obtained from citations, including BSERP Project, Phase II (2007) that occur as a continuation of the BSERP Project, Phase I (2003). The author of this paper has contributed as a specialist to the thematic area of pollution loads / discharges into the Bulgarian Black Sea.

Throughout the current research, calculations and evaluations for Figures 4, 5, 7, 8, 9, 10, and 11 were prepared by the paper's author for the BSERP Project, Phase II.

Influence of the Danube River on the Bulgarian Black Sea (Figure 12) was researched on DANUBS Project (2002), with participation of the author of this paper as report preparing research scientist on the thematic area of Hydrology and Hydrochemistry of the Bulgarian Black Sea.



Figure 1. Map of the Black Sea. The Bulgarian Black Sea is part of western zone of the Black Sea.

RESULTS AND DISCUSSION

In respect to marine pollution, the Black Sea is one of the world's most vulnerable areas as it refers to the internal continental seas, with limited contact to the World Ocean. Human activity has affected the Black Sea environment and its shores.

Pollution of the Bulgarian Black Sea refers to various discharges by rivers, municipal and industrial sources, agriculture, etc.

Discharges and pollution by rivers

The Bulgarian river watersheds belong to three major basins (Figure 2).



- Black Sea basin: most of the rivers in East Bulgaria;
- Danube river basin: most of the rivers in North Bulgaria
- Aegean Sea basin: most of the rivers in Central and South-West Bulgaria.

The positions of these three basins are shown by different colors on the adjacent picture.

Figure 2. Bulgarian watersheds (NIMH, 2007).

The names of the rivers that discharge into the Bulgarian Black Sea are listed in Figure 3. Major rivers are the Kamchia River, the Aheloy River, the Batova River, the Dyavolska River, the Dvoinitsa River, the Hadjiska River, the Karaach River, the Rezovska River, the Ropotamo River, and the Veleka River.



Figure 3. Bulgarian Black Sea catchment.

Total rivers discharge into the Bulgarian Black Sea ranges from $556.35 \times 10^6 \text{ m}^3 \text{ yr}^{-1}$ to $2994.75 \times 10^6 \text{ m}^3 \text{ yr}^{-1}$, and the Kamchia River has considerable contribution with water discharge between $179.29 \times 10^6 \text{ m}^3 \text{ yr}^{-1}$ and $1475.28 \times 10^6 \text{ m}^3 \text{ yr}^{-1}$ (Figure 4).

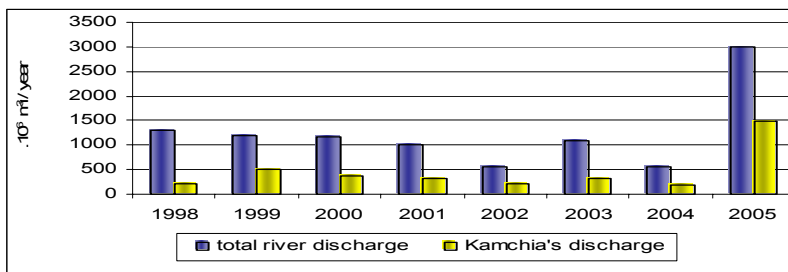


Figure 4. Total river discharge ($\times 10^6 \text{ m}^3 \text{ yr}^{-1}$) and the Kamchia's discharge ($\times 10^6 \text{ m}^3 \text{ yr}^{-1}$) during 1998 - 2005.

The other important rivers, forming the watershed of the Black Sea in Bulgaria are the Rezovska River and the Veleka River (Figure 5), with discharge respectively up to $248.69 \times 10^6 \text{ m}^3 \text{ yr}^{-1}$ and $577.49 \times 10^6 \text{ m}^3 \text{ yr}^{-1}$.

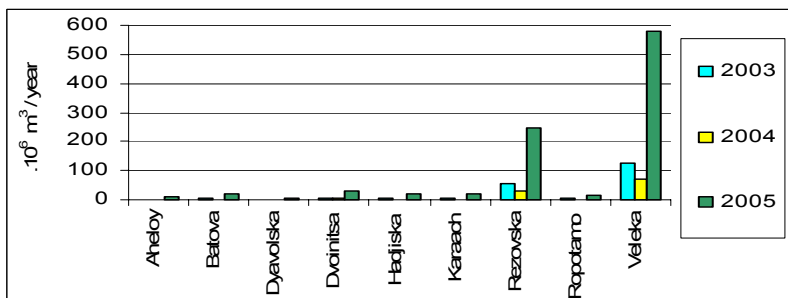


Figure 5. Discharges ($\times 10^6 \text{ m}^3 \text{ yr}^{-1}$) of the Aheloy River, the Batova River, the Dyavolska River, the Dvoinitza River, the Hadjiska River, the Karaach River, the Rezovska River, the Ropotamo River, and the Veleka River during 2003 - 2005.

Biochemical Oxygen Demand (BOD) is often used for assessment of the degree of organic pollution of the water.

In terms of BOD-5, considerable organic pollution of the Black Sea through rivers is caused by the Danube River – 75 % while the share of rivers of Ukraine, Russia, Turkey, Romania, Georgia and Bulgaria ranges from 1 % to 6 %, with 1% of Bulgaria's Rivers, and the Dniepr River rate is 5 % (Figure 6).

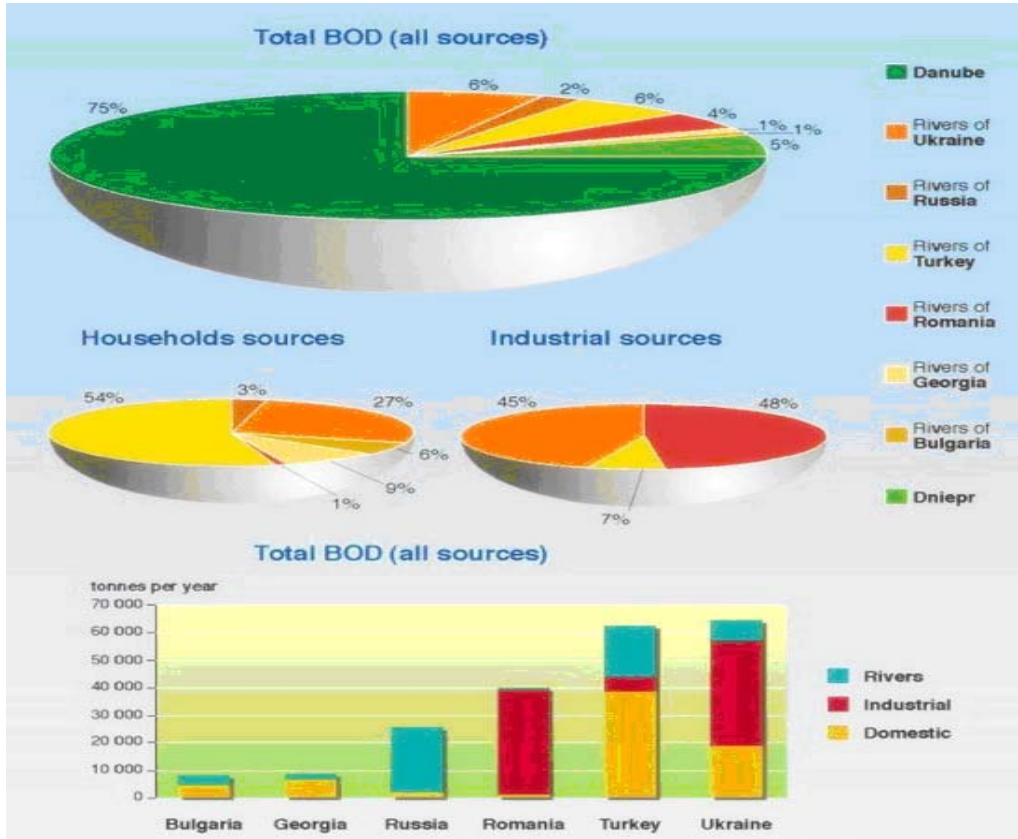


Figure 6. Biochemical Oxygen Demand (UNDP, 1997; GRID-Arendal, 2001; UNEP GIWA, 2005).

Organic pollution comes from the Bulgarian Black Sea coast mainly by two sources – rivers and domestic (Figure 6). As to house sources, the share of Bulgaria is 6 % among the Black Sea countries.

Organic pollution discharge into the Bulgarian Black Sea by rivers, measured by BOD-5, ranges from 2000 t yr⁻¹ to 7158 t yr⁻¹ (Figure 7), with share of the Kamchia River between 608 t yr⁻¹ and 4146 t yr⁻¹.

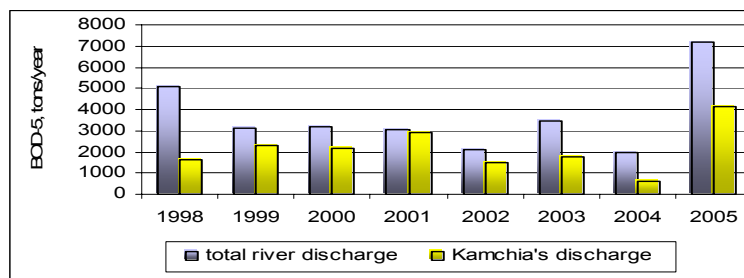


Figure 7. Organic pollution discharge into the Bulgarian Black Sea by rivers, assessed in Biochemical Oxygen Demand (BOD-5, t yr⁻¹), and rate of the Kamchia River's organic pollution discharge, assessed in BOD-5 (t yr⁻¹) during 1998 – 2005.

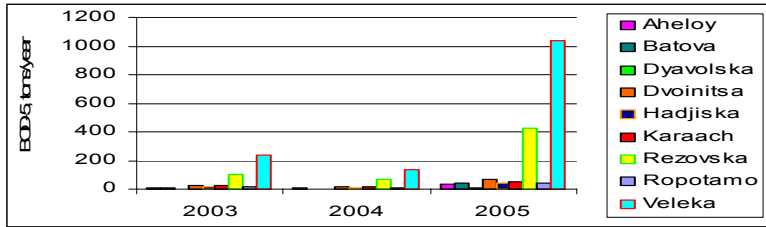


Figure 8. Organic pollution discharge into the Bulgarian Black Sea by the Aheloy River, the Batova River, the Dyavolska River, the Dvoinitsa River, the Hadjiska River, the Karaach River, the Rezovska River, the Ropotamo River, and the Veleka River, assessed in Biochemical Oxygen Demand (BOD-5, t yr⁻¹) during 1998 – 2005.

Organic pollution discharge into the Bulgarian Black Sea by major rivers (Figure 8), assessed in Biochemical Oxygen Demand (BOD-5) varies between 3 t yr⁻¹ (the Dyavolska River) and 1040 t yr⁻¹ (the Veleka River).

Eutrophication is a process of changing the nutritional status of the water body by increasing the nutrient resources. The eutrophication brings about oxygen depletion events. Nutrient enrichment is due to an excess amount of phosphorus and nitrogen compounds.

Total nitrate nitrogen discharge into the Black Sea by Bulgaria's rivers (Figure 9 A.) is between 885 t N yr⁻¹ and 5098 t N yr⁻¹, with the Kamchia River's contribution from 520 t N yr⁻¹ to 3278 t N yr⁻¹.

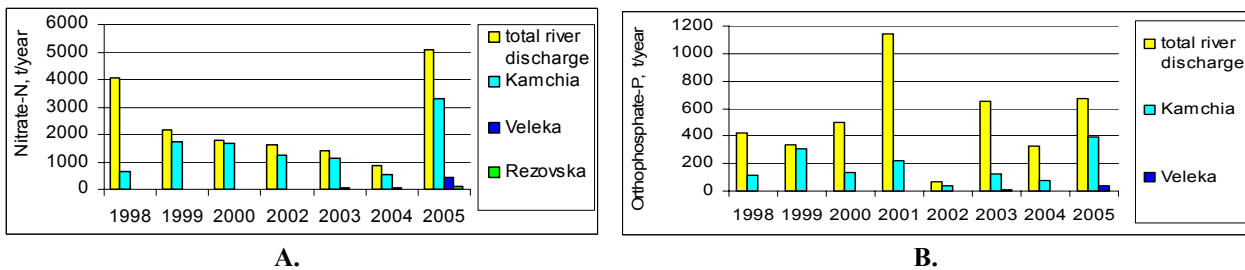


Figure 9. Nutrient discharge into the Bulgarian Black Sea by rivers during 1998–2005. (A) Nitrate-N (t N yr⁻¹). (B) Orthophosphate-P (t P yr⁻¹).

Total orthophosphate phosphorus discharge into the Bulgarian Black Sea by rivers (Figure 9 B.) ranges from 65 t P yr⁻¹ to 1141 t P yr⁻¹, with the Kamchia River's rate between 36 and 222 t P yr⁻¹.

Heavy metals discharge (Figure 10) into the Bulgarian Black Sea by rivers is mainly formed by the Kamchia River as its total cadmium discharge is up to 10 t yr⁻¹ (Figure 10 A.), total zinc discharge - up to 125 t yr⁻¹(Figure 10 B.), total lead discharge - up to 118 t yr⁻¹ (Figure 10 C.), and total copper discharge – up to 44 t yr⁻¹ (Figure 10 D.).

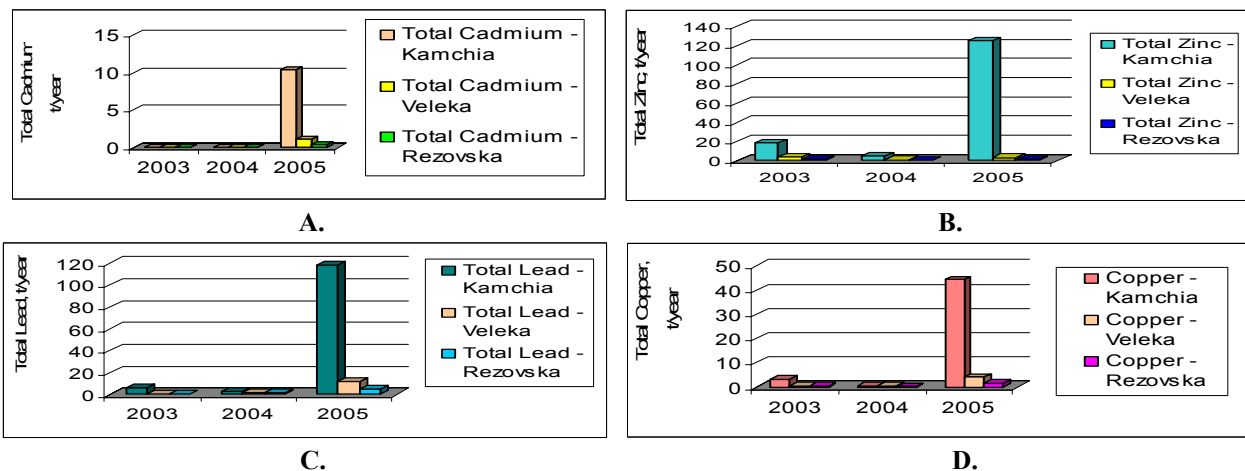


Figure 10. Discharge of heavy metals into the Bulgarian Black Sea by rivers during 2003 – 2005. (A) Total cadmium (t yr⁻¹). (B) Total zinc (t yr⁻¹). (C) Total lead (t yr⁻¹). (D) Total copper (t yr⁻¹).

Total Petroleum Hydrocarbons discharge (Figure 11) into the Bulgarian Black Sea by rivers is up to 458 t yr⁻¹, with the Veleka River's discharge - up to 116 t yr⁻¹, and the Rezovska River's discharge - up to 50 t yr⁻¹.

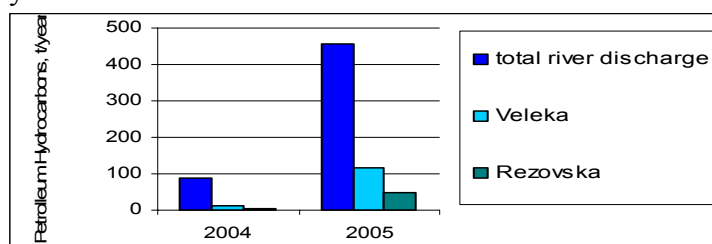


Figure 11. Petroleum Hydrocarbons discharge (t yr⁻¹) into the Bulgarian Black Sea by rivers during 2004–2005.

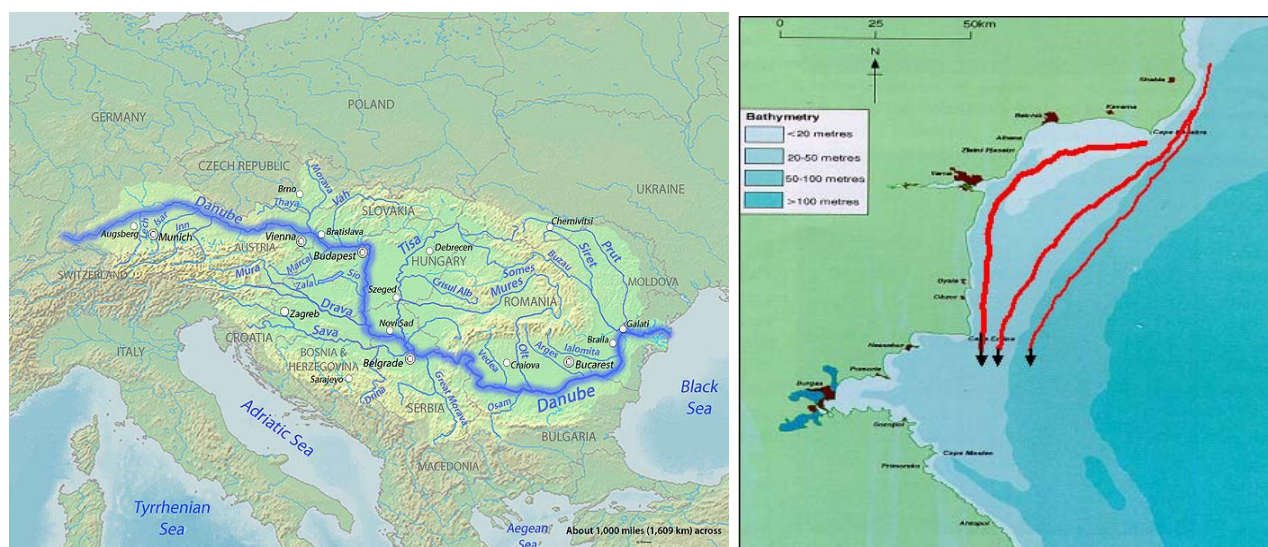


Figure 12. Influence of the Danube River. (A) Map of the Danube River basin. (B) The Danube current system in the Bulgarian Black Sea (DANUBS Project, 2002)

The Danube catchment (Figure 12 A) covers vast and polluted area. It is the second largest river basin in Europe, after Volga's watershed. It is also the basin that covers the greatest number of countries in the world. The Danube's catchment lies west of the Black Sea in Central and Southeast Europe. The Danube River discharges into the Black Sea via delta in Romania and Ukraine. The Danube River is the Black Sea's largest tributary, with an average discharge of 6 550 m³ s⁻¹.

Beginning in Germany, the Danube River flows across Austria, Slovakia, Hungary, Croatia and Serbia, it forms the border between Romania and Bulgaria, and discharge onto the Black Sea via delta in Romania and Ukraine as the greater part of the Danube Delta lies in Romania while the northern part is situated in Ukraine.

The key concern for the basin that has to be addressed is related to nutrient pollution and subsequent eutrophication - the cause of many environmental and water use problems.

The determination of the river borne nutrient amount, which might be disposed to a marine ecosystem without harm, requires a solid background knowledge about the ecosystem. This includes the original state of the ecosystem before anthropogenic pollution, the kind of pollution in the river and its impact on the marine environment, the kind and extent of damage to the ecosystem under pollution stress (DANUBS Project, 2005).

The Bulgarian Black Sea state under the Danube River influence (Figure 12 B) is key matter for research, including climate change impact (DANUBS Project, 2005; Dineva, 2005; Dineva, 2006; Dineva, 2007; Dineva, 2008; Dineva 2010).

Discharges and pollution by various land-based sources

The pollution of the Bulgarian Black Sea by diffuse sources (Povvik AD, 2009) comes from settlement without sewage or from poor working ones, from agriculture areas, treated with fertilizers, from livestock farming and using of the natural organic fertilizers, by automobile transport, and by illegal domestic solid waste disposal. That results in pollution with nitrogen, phosphorus and organic matter. The treatment of agriculture lands with chemicals for plant's protection is mainly with herbicides and rarely with insecticides. The transport is basic source of petrol and hydrocarbons pollution, as well as pollution by products of their dissociation.

There are 29 waste water treatment plants in the Varna and Dobrich provinces, that border on the Black Sea.

Municipal waste water treatment plants of Varna, Dobrich, Devnya, Golden Sands, and Albena discharge above $5000 \text{ m}^3 \text{ d}^{-1}$. The main Municipal waste water treatment plants with capacity below $5000 \text{ m}^3 \text{ d}^{-1}$ are in General Toshevo, Kavarna, Dolni Chiflik, Beloslav, and Provadia (RIEW-Varna, 2008).

Seven of the Municipal waste water treatment plants – of Balchik, Provadia, Slanchev Den, St. Konstantin and Elena, Euxinograde, Rusalka, and residential district Asparuhovo of Varna are only with mechanical treatment of the waste waters. Municipal waste water treatment plant of Varna is with the greatest waste water discharge into the Bulgarian Black Sea (RIEW-Varna, 2008).

Many of settlements with less than 2000 eq. residents are without sewage systems and waste water treatment plants (RIEW–Burgas, 2009).

Large amount of eutrophication matter come into the Bulgarian Black Sea due to lack of biological treatment in the waste water treatment plants (Dineva 2007).

In the coastal zone, major industrial sectors are located in Varna and Burgas areas.

Operational discharges are the major sources of pollution from shipping – oil and indigenous species. A maritime incident could lead to accidental spill. Along Bulgarian Black Sea coast, ports for Liquid Cargoes are situated in Varna and Burgas.

CONCLUSIONS

Major environmental threats for the Bulgarian Black Sea are untreated or not adequately treated waste waters, eutrophication (excess of nutrients), chemical pollution (toxic substances), oil spills, etc.

The research about water discharges into the Bulgarian Black Sea found out that actions are needed by governmental institutions to approach efficient water management, including on these lines:

- Implementing the best practices of water discharge management
- Developing an effective pollution defense strategy
- Efficient management of Bulgarian Black Sea watershed
- New solutions on municipal water discharge and installation of the necessary infrastructure related to appropriate treatment facilities
- Action to prevent illegal untreated waste water discharges
- Adapting techniques to meet industry challenges
- Involving in decision making process researchers, industry leaders and leading panel of shipowners and managers

In regard to the Black Sea pollution reduction in front of the Bulgarian coast and overcoming of the challenges, actions are needed by Basin Directorate for Black Sea region – Varna, Ministry of Environment and Water, Ministry of Regional Development and Public Works, Ministry of

Economics, Energetics and Tourism, Ministry of Finance, Ministry of Health, Ministry of Agriculture and Foods, etc.

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