Cost-effective reduction of eutrophication in the Gulf of Kalloni (Island of Lesvos, Greece)

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Abstract

This study presents a cost-effective analysis by comparing the costs of measures (options) to improve the quality of bathing waters in the Gulf of Kalloni (island of Lesvos, Greece) in order to reduce the anthropogenic eutrophication in the coastal water of the Kalloni Gulf.

The Gulf of Kalloni is a semi-enclosed gulf (115 km^2) which receives municipal wastewater, agricultural activity drainage, and periodic waste from olive oil plants processing the local olive harvest. The area of study consists of the coastal waters of the river basin from which water run-off drains into the gulf. Four options are comparable in their environmental effectiveness to reduce eurtophication damage. These are: a municipal wastewater treatment plant, construction of dams, organic farming plus training and an olive oil wastewater treatment plant.

Keywords: Cost-effective analysis, Environmental effectiveness, Coastal management, Lesvos.

Introduction

The purpose of this study is to compare the costs of measures to improve the quality of bathing waters in the Gulf of Kalloni by reducing anthropogenic eutrophication in the coastal waters of the Gulf.

The Gulf of Kalloni is a semi-enclosed gulf, which receives municipal wastewater, agricultural activity drainage, and periodic waste from olive oil plants processing the local olive harvest. The area of study consists of the coastal waters of the river basin[(1)] from which water run-off drains into the gulf. The land area consists of 50% level areas, 40% semi-mountainous and 10% mountainous areas.

Eutrophication damages the water

[(*)] The views expressed in this article are those of the authors and do not in any way reflect positions of the European Commission or the National Centre for Marine Research.

ecosystem, causes loss of amenities for local residents and tourists, and thereby leads to environmental and socio-economic losses. Eutrophication does not endanger human health but its effects are considered to be aesthetic pollution. Eutrophication is one of the parameters of the EC Directive on bathing water and its proposed amendments. On current trends, if eutrophication is left uncontrolled, further increases in its effects must be expected with ensuing degradation of ecological quality[2].

While the causes of eutrophication are well understood and remedial measures well-known, the costs of such measures have been little studied. The following work intends to provide an overview of some direct costs of preventive measures to reduce excess nutrients.

Socio-economic background

Municipalities and Tourism

Several municipalities drain their wastewater into the Gulf of Kalloni. They have about 13400 inhabitants[3], predominantly employed in the primary and tertiary sector (about 40% each). Tourism activities are steadily increasing. Less than 20% of the population work in the secondary sector.

Between 300 and 1300 tourists visit the area at anyone time. They stay mostly on the coast[4]. Numbers are expected to increase. According to 1997 estimates by the Lesvos National Tourism Organisation, hotel capacity will further rise by 20% in 1998, due mainly to increases in alternative forms of tourism, such as agro- and eco-tourism, and bird watching. The area under study, and especially the municipality of Kalloni, is known for its wetlands and rare kinds of avi-flora. However, tourists do not accept the visible effects of eutrophication (alga growth, low water transparency, green water colour and slime). Currently, these problems are confined to certain areas, but they will spread further if nothing is done to reduce emissions. Some neighbouring regions do already attract greater numbers of tourists (despite comparable levels of infrastructure availability), arguably because of better water quality.

Agriculture

Land use has changed considerably in the last few decades. Cultivated land areas increased greatly in the 1970's, mainly due to agricultural subsidies, stabilised in the 1980's, and are now decreasing in line with set-aside schemes (fallow land)[5] (Table 1).

Forests areas continue to decrease because of fires and lack of protection. Former forest areas are used for crops and grassland. Revenues from forestry activities are negligible (1% of Gross Agricultural Product). Also, there is a decrease in areas covered by water which stems from extending settlements and from the construction of flood-controls and drainage works.

Arboriculture (trees) is the main agricultural activity and continues to increase its share (1993: 70% of total cultivated area,

Table 1
Land use.

[km^2= 100 hectares]	1971	1981	71/81 %	1991	81/91 %	1995	91/95 %
Cultivated land	120	129	+7	130	+1	108	-7
Fallow land	-	-	-	0	0	10	
Grassland	138	139	+1	145	+4		
Forests	106	95	-11	92	-3		
Areas covered by water(lakes, rivers)	6	5	-9	4	-10		
Built-up areas (incl.roads etc)	13	10	-22	11	+11		

Table 2
Cultivated and irrigated areas in 1995.

[hectares]	Tree culture	Ploughed culture	Vineyard	Horticulture	Total
Cultivated	8740	2110	230	230	10840
Of which irrigated	630	740	50	220	1640
Irrigated in%	7%	35%	25%	96%	15%

1995: 76%). Practically all of this arboriculture (99%) is olive trees for olive oil production. The launching of organic olive tree farming with considerably reduced environmental impact has been used with success (130 hectares since 1995 in the settlement of Achladeri).

The livestock sector consists of only one intensive unit for poultry breeding (settlement of Polichnitos). There are no intensive pig farms and no large-scale cattle farms. Therefore, pollution from livestock is very limited. The increase in grasslands also stems from areas formerly covered by water. Fishing is an important local activity with a volume of 1205 tons in 1995. The Gulf of Kalloni is famous for sardines and shellfish.

Only 15 % of cultivated land is irrigated (Table 2).

Olive oil plants

The manufacturing sector is mainly made up of six olive oil plants creating peak water pollution during their operational period from October to May, especially in December and January. Olive oil production is increasing at the rate of 1.7 % a year (GAVRILAKIS & GEORGIADIS, 1996). Also, there are only some small manufacturing units processing agricultural products for local consumption.

The Eutrophication Problem

Parameters

Two nutrients are the main causes of eutrophication in the Gulf of Kalloni:

nitrates and phosphates. For measurement purposes, generally the two proxy parameters chlorophyll-a concentration and transparency are used.

Chlorophyll-a concentration increases with increased phytoplankton, which grows from the nutrients nitrates and phosphates. The chlorophyll-a concentration in the Gulf of Kalloni ranges from 0.42μg/l to 2.15μg/l (NCMR 1997, PAVLIDOU *et al.*, 1997), i.e. fair to bad quality according to the "good status" criteria of recently proposed European Community legislation[6]. Either one, nitrates and phosphates called limiting factors for eutrophication, which means that a reduction in one would generally yield a bigger reduction in eutrophication[7]. In the case of the Gulf of Kalloni, phosphates seem to be the limiting factor (NCMR, 1997).

Water transparency decreases with high nutrient levels. Transparency in the Gulf of Kalloni (NCMR, 1997) is 15m in the summer ("good quality" in the Mediterranean is 10-19 m) and 3-5 m during the other seasons (fair quality: 5-9 m, bad quality: < 5 m). In other words, quality is fair to bad, except in summer when it is good due to the fact that rivers have dried up. After storms and heavy rainfall, however, swollen rivers bring nutrients into the Gulf and transparency decreases to below 10 m (high aesthetic pollution). Bad transparency during the other seasons is caused by heavy rainfall, the operation of olive oil plants, and overuse of fertilisers for crops during the winter[8].

For reasons of simplification in this study, nitrate and phosphate emission reduction options are compared directly.

Origins of nutrients

In the river basin soils have poor capacity to absorb nutrients and thus facilitates superficial run-off. With storms being the dominant form of precipitation, dry rivers turn into torrents and high levels of nutrients are washed into the Gulf. Because wetlands have greatly decreased in size and estuaries have been aligned, large amounts of nitrates and phosphates end directly in the Gulf, resulting in the sudden emergence of significant eutrophication.

Eutrophication in the Gulf of Kalloni is man-made (as opposed to natural eutrophic conditions). Such were the conclusions of a major study carried out by the National Centre for Marine Research in Greece. The nutrient inputs into the coastal waters of the Gulf stem from agriculture, domestic water uses, and the agro-industry sector in the river basin. The approximate portions are presented in the Table 3.

On current development trends in these sectors and their nitrate and phosphate emissions, eutrophication is likely to worsen in the future.

Options for reducing eutrophication

Measures for reducing emissions of nitrates and phosphates differ for households, agriculture, and olive oil plants. Each is now analysed separately. As it is impossible to exactly predict reductions in nutrient loading exactly, this paper strives to compare costs of options with comparable effectiveness, i.e. reduction in nitrates and phosphates. Moreover, only options with a fair chance of realisation and with reasonable availability of cost data have been assessed.

For the purpose of comparing options with different cost profiles over time two measures will be calculated for each of them:
▶ Net Present Value of Total Costs = NPVTC,
▶ Equivalent Annual Costs = EAC.

The Net Present Value discounts all future costs and revenues to the present day. In this study, a discount rate of 6% is assumed, considering the average long term return on government bonds plus a margin for risk (E.C/DG Regional Police and National Bank of Greece). However, Net Present Values for different periods are not comparable. So, to avoid using very long periods as common denominators, the measure Equivalent Annual Costs is used. It reveals the average annual payments (annuity) associated with an investment over a certain period.

Finally, immediate capital investment for the first year is compared as a way to assess early investment needs.

Municipal wastewater treatment

Municipal wastewater is the largest source of phosphates. The construction of purification plants (biological treatment of wastewater) will contribute to decreasing emissions of nitrates and phosphates into the Gulf.

Table 3
Emission of Nitrates and Phosphates.

Activity	Nitrates (NO$_3$)	Phosphates (PO$_4$)
Municipal wastewater	38%	60%
Agriculture	60%	20%
Olive oil plants	2%	20%
Total	**100%**	**100%**

Adapted from: NCMR, 1997; NB: Fish-farming activity has ceased

Municipalities emit nutrients into the Gulf to different extents, depending on geographical location, population numbers, demographic trends, tourism trends, and economic growth. For the coming years it has been assumed that 60% of domestic emission will come from the municipality of Kalloni, situated in the inner part of the Gulf where the waters do not easily recycle and therefore cause greater pollution. Its settlements are along the coast and population (about 40 % of total) is expected to increase with increases in tourism and economic growth. Two of the five "bathing areas" in the Gulf belong to this municipality[9].

Option A: Kalloni biological wastewater treatment plant

Emission reductions

Given that the treatment plant in Kalloni would reduce emissions of N and P by 60%, in accordance with the EC Urban Wastewater Treatment Directive (91 / 271 / EEC), since municipal emissions make up 38% and 60% of overall N and P emissions respectively, overall emission reduction would amount to 23% for nitrates and 36% for phosphates.

Financial costs

The treatment plant would engender fixed costs for buildings, a nitrates unit and the outlet pipe network, a phosphate abstraction unit (and machinery), and an inlet network, as well as variable cost of operation and maintenance[10]. The fixed costs have economic lives of 30 or 10 years until replacement is needed (Table 4).

Reducing agricultural emissions

Agricultural drainage is the largest source of nitrate leaching (60% of overall emission into the Gulf) and is a major source of phosphates (20%). Unlike municipal wastewater, agricultural emissions of nitrates and phosphates can be reduced at source. Two options in particular have been studied:

B1: Construction of irrigation dams,

B2: Payments for organic farming and training

Table 4
Financial costs of wastewater treatment option.

(in thousand ECU)

Economic life / Cost element	30 years	10 years	Annually
Main buildings, nitrates unit, outlet pipes	450		
Machinery		550	
Phosphate abstraction unit	50		
Machinery		130	
Inlet network	320		
Operation & Maintenance			30
Total	820	680	30
	FC_{30}	FC_{10}	VC
NPVTC$_{A1}$ over 30 years at 6% discount rate	820	[11]1270	[12]410

➤ **NPVTC**$_{A1}$ = FC_{30} + FC_{10} + VC = 820 + 1270 + 410 = **2.5 million ECU**

➤ **EAC**$_{A1}$ = $\dfrac{NPVTC_{A1}}{\sum\limits_{1}^{30} 1\big/(1.06)^t}$ ⟹ **0.18 million ECU**

Option B1: Three irrigation dams

Only 15% of the cultivated land is currently irrigated (Table 2). Where cultivated land is not irrigated farmers many times use larger quantities of fertilisers, which are washed into the Gulf with heavy rainfalls because of the low soil absorption in the region studed. When irrigated, combined with the persistent high temperatures, nitrogen compounds are denitrified into aerial nitrogen and are consequently not carried into the Gulf. Currently, almost all nitrate and phosphate emissions stem from non-irrigated areas. Correct irrigation would also help soil absorb fertilisers, thereby removing them from the surface (VAVIZOS, 1997).

Emission reductions

In the river basin the building of three dams is being studied for the areas of Kerami, Tsiknia, and Basilika. It can be assumed that they will increase the irrigated area in the Gulf of Kalloni from approximately 15% to about 45% of the total agricultural area. Furthermore, non-irrigated areas would emit only 30% of nitrates and phosphates compared to irrigated areas.

If 30% of the total cultivated area were switched from non-irrigated to irrigated, agricultural emissions would be reduced by about 20%. Given the share of agricultural emissions in overall emissions, a reduction of 12% for nitrates and 4% for phosphates would result.

Financial costs

Fixed costs of constructions are estimated to be ECU 2.6 million for Kerami, ECU 3.9 million for Tsiknia, and ECU 2.6 million for Basilika. Hence, construction costs of all three dams add up to some ECU 9 million[13]. The economic life of these is set at 50 years. Furthermore, some machinery, such as injectors for drip irrigation, need to be purchased and installed at a cost of ECU 3 million (=3000 hectares to be switched at ECU 1000 per hectare). Injectors have an economic life 10 years (*Ministry of Agriculture*). Variable costs of operation and main-

Table 5
Financial costs of dam option.

(in thousand ECU)

Economic life Cost element	50 years	10 years	Annually
Construction for Kerami	2600		
Construction for Tsiknia	3900		
Construction for Basilika	2600		
Injectors and other machinery		3000	
Inlet network	320		
Operation & Maintenance (3000 hectares)			60
Total	9000		
	FC_{50}	FC_{10}	VC
NPVTC$_{B1}$ over 50 years at 6% discount rate	9000	[14]6420	[15]910

➤ **NPVTC$_{B1}$** = FC$_{50}$ + FC$_{10}$ + VC = 9000 + 6420 + 910 = **16.3 million ECU**

➤ **EAC$_{B1}$** = $\dfrac{NPVTC_{B1}}{\sum\limits_{1}^{50} 1 / (1.06)^t}$ ⟹ **1.1 million ECU**

tenance are estimated at ECU 200 per hectare annually (Table 5).

Option B2: Payments for organic farming and training

Organic farming generally improves the quality of the landscape, biodiversity and the management of nitrate pollution[16]. The EC Nitrates Directive[17] and "Agenda 21" too, advocate training and non-regulatory approaches to encourage best environmental practice by farmers in their use of fertilisers. An economic analysis can highlight the financial aspects of effective incentive schemes.

Emission reductions

Only very little quantitative data is available on the environmental benefits of organic farming. Appropriate indicators are only now being developed. Some monitoring and evaluative studies have been finalised[18]. A few studies have also developed numerical estimates of nutrient leaching. No measures of nitrate concentrations in aquifers are yet available. Results for the Netherlands, the UK, Denmark, Germany, and other EU countries should be interpreted with caution for Greece. However, the importance of adequate education, training, and advice on good organic farming practices, is obvious from the studies. In addition, it is important to provide sufficiently high levels of financial support as an incentive for lasting change.

For the purposes of this study we assume that organic farming practices (by olive farmers) lead to zero emission levels of nitrates and phosphates (STOPES, 1997). To achieve an overall emission reduction of 30% for nitrates and 10% for phosphates into the Gulf, half of all farmers would have to convert to organic farming practices.

Financial costs

The following calculation sets out the minimum necessary expenditure to ensure organic farming practices for half of the agricultural areas. Costs for monitoring personnel and marketing services are not calculated separately.

- Training for 1500 farmers for 100 hours (theory and practice) costs about ECU 1.2 million (including an incentive payment to farmers, payments of trainers, travel, documents etc.) [19].
- Income losses during a transitional period can be calculated using the EC agri-environment regulation COM 2078/92 as a benchmark. Its aid payments for stimulating the use of organic farming methods cover "additional costs" or "income foregone"[20]. In Greece, the level of the premium covers the conversion period of 5 years and depends on the crop (Table 6)[21].

Treatment of discharge of waste from olive oil plants

Two treatment methods have been studied for reducing emissions from olive oil plants: wastewater treatment plants and a filter technology, which, though, is still in an experimental stage.

Option C1: Wastewater treatment plants

Such wastewater treatment plants would require new installations because current treatment capacities in the municipalities are not equipped to handle the periodically high influxes. Discharge from each olive oil plant is on average 30 m^3 per day in peak periods. This is equivalent to the wastewater volume from about 20000 inhabitant.

Emission reductions

The treatment plants would eliminate nitrate and phosphate emissions from olive

Table 6
Current support payments for ploughed, tree and vineyard cultures.

	Area (hectare)	Support ECU/hectare	Total ECU/year
Grains	450	150	67500
Vegetables (40 hectares) Water melon (90 hectares) Melon (40 hectares) Potatoes (120 hectares) Kitchen garden (110 hectares)	400	250	100000
Olive trees	4050	133	538650
Vineyard culture (table grapes)	60	670	40200
Total			**746350**

Training and compensation payments add up to:

$NPVTC_{B3}$ = 1.2 million ECU (for training) + 3.1 million ECU[22] = 4.3 million ECU

EAC_{B3} = 4.3 million ECU / 4.2 $\cong$ 1 million ECU

Table 7
Financial costs for one olive oil wastewater plant.

(in thousand ECU)

Economic life Cost element	30 years	10 years	Annually
Main buildings, phosphate unit, outlet pipes	870		
Machinery		1070	
Operation & Maintenance			50
Total	870	1070	50
	FC_{30}	**FC_{10}**	**VC**
NPVTC over 30 years at 6% discount rate	870	[23]2000	[24]680

Building five treatment plants (for six communities) would amount to:

➤ $NPVTC_{C1}$ = 5 * (FC_{30} + FC_{10} + VC) = 4350 + 10000 + 3400 = **17.7 million ECU**

➤ EAC_{C1} = $\dfrac{NPVTC_{C1}}{\sum\limits_{1}^{30} 1\big/(1.06)^t}$ $\Rightarrow$ **1.3 million ECU**

oil plants and would therefore reduce overall emissions by 2% for nitrates and 20% for phosphates.

Financial costs

See Table 7.

Conclusions

The results of this study have to be considered with caution because concentrations of excess nutrients in coastal waters change rapidly which makes all summary conclusions uncertain.

Therefore, four options that are roughly comparable in their environmental effectiveness, i.e. their reduction levels of nitrates and phosphates, have been studied to avoid further inquiries into the uncertain environmental effects. Still, since for these options cost structures over time vary considerably, the two measures Net Present Value NPV and Equivalent Annual Costs EAC have been calculated (Table 8).

Two options appear to have the most favourable NPVs and EACs: A1- Kalloni municipal purification plant and B2 - organic farming and training. Considering the wide gap between their costs and that of irrigation dams, it can safely be argued that the dam option does not constitute a cost-effective solution to the eutrophication problem in the Gulf of Kalloni. This holds true even when considering possible secondary benefits, such as flood control, electricity generation, and perhaps additional leisure possibilities.

Further efforts will be necessary to arrive at results that are more reliable and to better understand the environmental effectiveness of measures and the eutrophication dynamics in the gulf. This would also enable the further calculation of some other options, which are too uncertain to be included in this report, although they might constitute promising alternatives. These are:

- Rebuilding wetlands and
- Charging perpetrators and demand side management practices.

Furthermore, new technology for nutrient reductions could improve environmental effectiveness or reduce costs in the future and thus shift the balance between options.

Finally, political decisions are not only related to cost considerations. Often, an essential question is, who is going to pay. This is where economic instruments, such as charges could be better ways to make the polluters pay and reduce the eutrophication problem in the Gulf of Kalloni.

However, it is essential to bring together all the policy makers - stakeholders involved in the various phases of decision-making and the relevant phases of policy implementation, in order to combine top-down and bottom-up approaches. Cooperation in a round table or consortium, by the central, regional and local authorities, the production sectors and services (land owners, associations, entrepreneurs, experts), the research Institutes-Universities, the N.G.Os and the public could give the most cost-effective solutions to reducing the anthropogenic eutrophication in the coastal water of the Kalloni Gulf.

Table 8
Comparison of options and costs.

	Option A1	Option B1	Option B2	Option C1
Description	Municipal wastewater treatment plant	Construction of dams	Organic farming plus training	Olive oil wastewater treatment plant
Reductions of N	23 %	12 %	30%	2 %
Reductions of P	36 %	4 %	10%	20 %
Costs in the first year [million ECU]	1.5	12.0	0.7	2.0
NPVTC [million ECU]	2.5 (30 years)	16.3 (50 years)	4.3 (5 years)	17.7 (30 years)
EAC [million ECU]	**0.2**	**1.1**	**1.0**	**1.3**

Acknowledgements

Notes

[1] The river basin of the Gulf of Kalloni covers $270 km^2$ (land area: $155 km^2$, Gulf: $115 km^2$)

[2] See NCMR 1997.

[3] The total population of the island of Lesvos, according to the last census (1991), was 87152 inhabitants.

[4] National Tourism Organisation, North Aegean Directorate, Mytilene, 1997.

[5] Data in this section is adapted from the National Statistics of Greece. For 1995 data is available only for cultivated and fallow land.

[6] COM 97(47): Proposal for a Council Directive Establishing a Framework for Community Action in the Field of Water Policy.

[7] Nitrogen is generally regarded as the "limiting factor" for eutrophication in seawater, while phosphorus is for freshwater (DETR).

[8] In the Directive on bathing waters the guide value for transparency is 2m but without distinguishing between fresh and seawater. Also, no distinction is made between different sea regions (e.g. transparency in the Mediterranean is different from the North Sea). Greek legislation (OJ 438/3.7.86) prescribes greater values than the Directive on bathing water, i.e. for the Greek legislation the guide value is 5 m and the mandatory value is 2 m.

[9] "Bathing areas" as in the EC report on "Quality of Bathing Waters". This treatment plant alone would eliminate about 60% of all municipal nitrate and phosphate emissions into the Gulf of Kalloni. Elimination of the remaining 40% would require three further treatment plants, one in Polichnitos (20% emissions), one in the communities of Paraskevi and Napi, and another in the communities of Basilika and Lisvori (each 10% emissions). These are the locations of the other three bathing areas. The financial costs for building, operating and maintaining them can be estimated at roughly another ECU 2.5 million for Polichnitos and some more ECU 2.5 million for the remaining two sites. Since costs would increase disproportionately compared to emission reductions, building theses plants has not been studied further.

[10] Not included in any of the calculations is the cost of the land on which infrastructure is built, nor are public administration and control costs.

[11] $FC_{10} = 680 + \dfrac{680}{(1.06)^{10}} + \dfrac{680}{(1.06)^{20}} = 1270$

[12] $VC = {}_1\Sigma^{30} \dfrac{30}{(1.06)^t} = 410$

[13] Most irrigation dams can also be used for hydro-electricity generation. This aspect has been left aside for the sake of clarity. In any case, turbines etc. would generate extra costs to be covered by revenues. A more important use of irrigation dams lies in flood protection. However, this can also be considered a side effect, since in Greece flood protection is normally pursued by channelling estuaries (PARASKEVOPOULOS A.).

[14] $FC_{10} = 3 + \dfrac{3}{(1.06)^{10}} + \dfrac{3}{(1.06)^{20}} + \dfrac{3}{(1.06)^{30}} + \dfrac{3}{(1.06)^{40}} = 6.4$ million ECU

[15] $VC = {}_1\Sigma^{50} \dfrac{60}{(1.06)^t} = 910$

[16] Organic farming is selected out of several environmentally friendly farming practices because it is applicable to olive tree culture and has agreed certification schemes for its correct application (effectiveness).

[17] Directive 91/676/EEC on Nitrates obliges Member States (Article 4) to: "establish a code or codes of good agricultural practice, to be implemented by farmers on a voluntary basis" and to "set up where necessary a programme, including the provision of training and information for farmers, promoting the application of the code(s) of good agricultural practice".

[18] OECD (1997a); OECD (1996b); EC DG XI (1997a,b); Stopes Ch. (1997); Greenpeace 1995; Halberg N. *et al.,* 1995.

[19] Data source: Greek Productivity Centre (ELKEPA), Department of Lesvos.

[20] Annual average reduction of production over 5 years of conversion is approximately 10%-15%. During this period prices of organic farming products are equal to prices for conventional produce.

[21] Under Regulation 2078/92 the level of premiums and the support periods vary between EC Member States. Some countries have aid after the conversion period e.g. Sweden, Finland etc.

[22] $NPV_{Income} = {}_1\Sigma^{5} \dfrac{746350}{(1.06)^t} = 746350$ ECU x 4.2 = $= 3134670 \sim 3.1$ million ECU

[23] $FC_{10} = 1070 + \dfrac{1070}{(1.06)^{10}} + \dfrac{1070}{(1.06)^{20}} = 2000$

[24] $VC = {}_1\Sigma^{30} \dfrac{50}{(1.06)^t} = 680$

24

Medit. Mar. Sci., 2/1, 2001, 15-25

References

Doci, C., 1994. Water Pollution from Agricultural and Urban Diffuse Sources: its Nature, Extent, and Control, editor: Fondazione Eni Enrico Mattei, Italy.

DETR, 1997. Economic instruments for water pollution.

EUROPEAN COMMISSION, DG XI, 1997a. CAP-Environment, Case Study: Nitrate Sensitive Areas, England (653/CE 97/1693/13269).

EUROPEAN COMMISSION, DG XI, 1997b. CAP Environment, Case Study: Organic Farming Denmark (653/CE 97/1683/13269).

Gavrilakis, K. & Georgiadis, G., 1996. System of Elaboration of the Wastes of the Olive Oil Plants in Lesvos, BSc Thesis, University of the Aegean, Mytilini (in Greek).

GREENPEACE, 1992. Green fields - Grey future.

Halberg, N., Steen Kristensen E. & Sillebak Kristensen I., 1995. Nitrogen Turnover on Organic and Conventional Mixed Farms, Jour-nal of Agricultural and Environmental Ethics, 8(1), p. 30-51 .

NATIONAL CENTRE FOR MARINE RESEARCH (NCMR), 1997. Research of the Structure and Function of the Marinal and Coastal-line Ecosystem of the Gulf of Kalloni, Final technical report.(editors: P. Panayotidis & S. Klaoudatos)

OECD, 1992. Market and Government Failures in Environmental Management (wetlands and forests), Paris.

OECD, 1993. Agricultural and Environmental Policy Interaction, Paris.

OECD, 1996a. Saving Biological Diversity: Economic Incentives, Paris.

OECD, 1996b. The Environmental Effects of Reforming Agricultural Policies, A preliminary report (COM/AGR/CA/ENV/EPOC (96) 147/REV1).

OECD, 1997a. Evaluating Economic Instruments for Environmental Policy, Paris.

OECD, 1997b. US Experiences with Incentive Measures to Promote the Conservation of Wetlands, Report ENV/EPOC/GEEI/BIO (97) 9.

Pavlidou, A., Kontogiannis Ch., Anagnostou Ch., Asymakopoylou G., & Panayotidis P., 1997. "Nutrients in Kalloni Gulf: Source, Distribution, Spending" in: Proceedings of the 5th Conference on Environmental Science and Technology, Vol. 2, p. 318-325, 1-4 September, Molyvos, Lesvos (in Greek).

Stopes, Ch., & Woodward, L., 1997. Nitrate Leaching in Organic Farming, IFOAM-Ecology and Farming, January, p. 23.

Vavizos, G., 1997. The Effects on Natural Resources of the Application of CAP, Technical report, Office of consultant.