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OPTIMA

Optimisation for Sustainable Water Resources Management

Instrument type: Specific targeted research or innovation project

Priority name: SP1-10

D02 Socio-Economic Framework Analysis

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Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

WP 02: Socio-economic framework: objectives, criteria, indicators

Part III Socio-economic analysis: issues and indicators

Preamble: acknowledgements

The present report provides a further elaboration of the requirements and constraints analysis for the optimum management of water resources, particularly in the context of the socio-economic framework.

Part I of this report documents the outcome of the discussions and review by all the OPTIMA partners at the Izmir Management Board Meeting of both the initial checklist of water issues, the concepts as defined in the glossary and the issues questionnaire.

Part II provides the findings of the analysis, carried out by FEEM, of the replies to the updated water issues questionnaire, and incorporates an overview of the respondents, i.e. the stakeholders in the respective case study areas, provided by Corridoio Zero. The effort of the 7 case study partners in OPTIMA, to establish direct contact and eventually post the replies that were obtained on the on-line database of replies - within a relatively short period of time - is duly acknowledged.

Part III elaborates further on the socio-economic framework analysis, and includes the contributions provided by INTERGEO and NCRS on technological change and landuse change respectively, as driving forces for the construction of plausible development scenarios.

IRMCo (WP02 Leader)
2 September 2005

Part I Identification of Problem Issues

1. Scope and objectives

WP02 “Socio-economic framework: objectives, criteria, indicators” forms part of four OPTIMA workpackages that represent the logical continuation of WP01 “Requirements and constraints analysis”. Indeed, also WP03 “Analytical tools: simulation and optimisation models”, WP04 “Techno-economic data compilation and analysis” and WP05 “Land use change: Remote sensing and GIS data”, have been designed to rely on and complement the results that emerged from an exhaustive review of data requirements and constraints.

The integration of the findings from these workpackages is the object of WP06 “Systems integration and implementation”, in order to then implement these to the case studies, in view of further analysis and dissemination (WP14, WP15 and WP16 respectively).

As shown in Fig. 1, the scope of WP2 is intended to also further progress the participatory approach with stakeholders as well as the prospective end-users of the OPTIMA results.

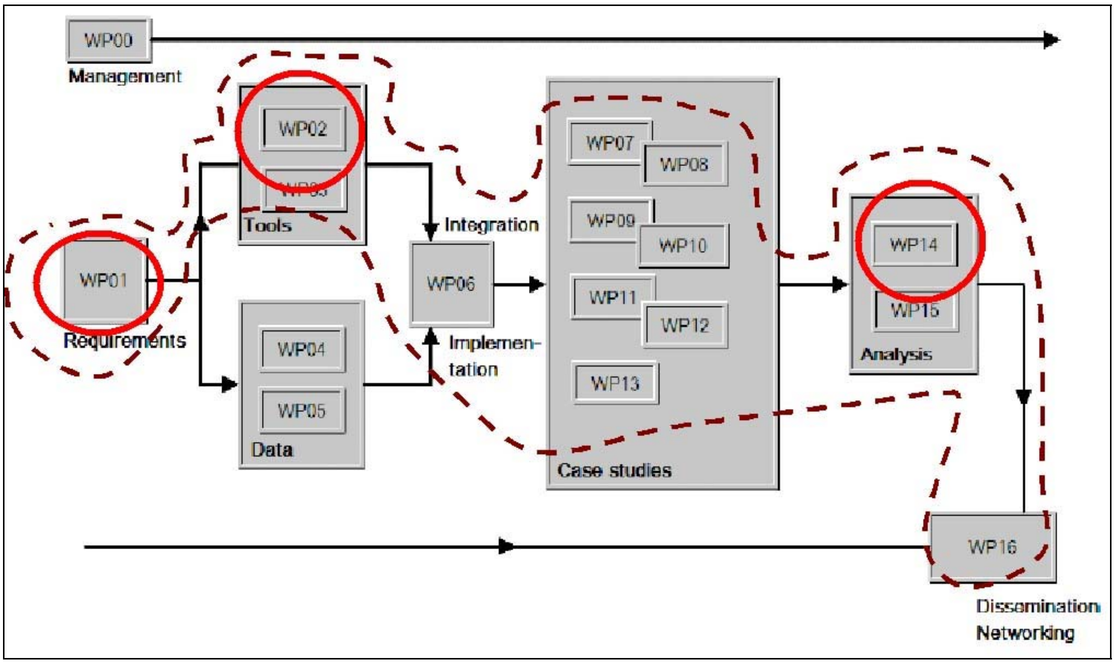

Fig. 1: Participatory stakeholder approach throughout the OPTIMA project lifecycle

Indeed, the participatory approach is viewed as a means to develop the tools needed for an optimum management of water resources in direct, active consultation with the stakeholders, leading to the creation of a favourable "atmosphere" that is aimed at gaining the understanding and acceptance of the eventual OPTIMA findings by all stakeholders.

The active involvement of the stakeholders is also considered as a means to assist, first and foremost, in the identification of any “conflicting” demands on the water resources, which could then be further assessed in the context of possible 'development scenarios', with a view to demonstrate through the use of appropriate modeling tools how such conflicts could be reconciled in the context of a sustainable approach to water resources management.

The specific objectives of WP02 "Socio-economic framework: objectives, criteria, indicators" can be summarised as follows:

- **Identify** the main **driving forces** : demographic change, economic development, land use change, technological change, institutional change
- **Define** the set of **objectives, criteria, and constraints** relevant to ICZM and sustainable development, analyse gender specific impacts
- **Define** a set of **indicators** in cooperation with local actors, covering the **social aspects** of water resources research (access, equity), obtain and maintain gender specific data on issues where possible
- **Review** and adapt practical **valuation methods for these indicators**
- **Analyse** the **decision making process** with emphasis on the major actors and their roles within the **regulatory and economic framework** (water market, pricing, taxes, subsidies)
- **Identify** possible **barriers** to the implementation of **techno-economically** optimal solutions
- **Design** an **evaluation and feedback mechanism** to analyse the decision making process

2. Identification of Problem Issues in active consultation with Stakeholders

With the above objectives in mind, a database of stakeholders has been created (see http://www.ess.co.at/OPTIMA/cases.html), the structure of which was elaborated in WP01 "Requirements and constraints analysis".

In parallel to this, also a comprehensive inventory of issues, deemed relevant to the requirements of an optimum management of water resources, was elaborated. As a point of departure, the case study partners were invited to fill out the resulting water issues questionnaire and a preliminary comparative analysis across the 7 case studies was made based on the so-called factor analysis.

This provided an important "testing ground" to verify the adequacy of both the inventory of issues itself, and the use of the questionnaire. Consequently, the OPTIMA management board meeting held in Izmir during 1-2 April 2005 allocated substantial time to go over the definitions, the first replies to the questionnaire as well as the preliminary analysis that ensued, to ensure a common interpretation of the issues and use of the questionnaire would emerge across the 7 case studies.

A short review is presented below, summarizing the discussions that resulted from the Izmir management board meeting, the corrective or further actions that were planned as a result of these discussions and their outcome.

Water Issues Questionnaire

Objective: to establish a comprehensive inventory or **checklist of possible issues**, so that the same checklist can be used across the 7 case studies.

Observation: while the glossary of terms, available also on-line, proved most valuable, not all terms were interpreted in the same manner by all partners (e.g. "access to water"). Also, some confusion emerged with regard to the distinction between "water supply" and "water demand" and their respective definitions. Consequently, it was opted to go through the initial questionnaire in more detail and to invite especially each of the case study partners to seek further clarification where needed.

Planned action: revisions would be made to the Questionnaire and the Glossary addressing the comments that emerged from the joint discussion by all partners and a final version would be issued by FEEM (WP01 leader) shortly after the Izmir meeting.

Outcome: a final version of the questionnaire was issued which distinguishes between 64 different issues. Both the updated questionnaire and the glossary of terms are available on-line (see http://www.ess.co.at/OPTIMA/issues.html and http://www.ess.co.at/OPTIMA/glossary.html). The full inventory list of the 64 issues taken up in the Questionnaire is shown in Appendix 1. The underlying structure of the inventory is presented in Table 1 below.

Main categories	**Level 1 Sub-categories**	**Level 2 Sub-categories**
Physical conditions	Water scarcity	
	Floods	
	Droughts	
	Groundwater quan/qual	
	Watershed degradation	
	Coastal interaction	
Water management	Institutional framework	Institutional responsibilities
		Active participation
		Private sector participation
	Regulatory framework	Water quality standards, enforcem.
		Water rights, conflict resolution
		Public information access rights
	Water pricing policies	Too high, restrictive prices
		Too low, no controlling effect
		Deficiencies in tariff structure
	Education and awareness	
	Gender issues	Equity in education, training
		Women in institutions
	Technology and investments	Obsolete technologies, maintenance
		Techno-economic barriers

Water Demand	Households	Water quantity (2 level 3 sub-cat.)
		Water quality (4 level 3 sub-cat.)
		Water saving technologies
		Impacts of population growth
	Tourism	Water quantity (2 level 3 sub-cat.)
		Water quality (2 level 3 sub-cat.)
		Water saving technologies
		Increasing demands by sectoral growth
	Agriculture	Water quantity (2 level 3 sub-cat.)
		Water quality (2 level 3 sub-cat.)
		Water technologies
		Agricultural expansion
	Industry	Water quantity (2 level 3 sub-cat.)
		Water quality (2 level 3 sub-cat.)
		Water saving technologies
		Impacts of industrial growth
	Other issues (environment, shipping, flood control)	Environmental water allocation
		Shipping
		Flooding
Water Supply	Quantity	Conflicts from limited surface water
		Conflicts from limited groundwater
		Alternative water resources
		Dependency on water imports
	Quality	Surface water quality
		Groundwater quality
		Limits to domestic use
		Limits to recreational use
		Limits to agricultural use
		Limits to industrial use
	Infrastructures	Abstraction, reservoirs, water harvesting
		Sanitation: sewers and treatment
		Distribution losses (canals, pipes)
		Preservation of natural resources (2 level 3 sub-categories)

Table 1 Underlying structure of checklist of issues

In addition, it was decided to consider a more refined 'response scale'. The selectable options that were used for the ranking of the issues in the initial questionnaire were restricted the ones reported in Table 2 below.

Not applicable	Marginal	Important	Very important

Table 2: Available options to rank the Issues in the initial questionnaire

The revised questionnaire considers a 7-point symmetric ordinal scale, anchored to: "Extremely Unimportant" and "Extremely Important" (the intermediate ratings, when necessary, have been labelled as "Very Unimportant", "Unimportant", "Neutral", "Important", "Very Important", respectively. Two further selectable options are labelled "undefined" and "don't know".

Replies to Water Issues Questionnaire

Objective: to collect and document the **priority ranking of issues as perceived by local actors** (stakeholders and end-users) in 7 case studies

Observation: First, it is reminded that the structure of an on-line database of stakeholders was developed as part of WP01. Although the database rapidly grew in size across the 7 case studies, only a relatively small number of stakeholder records that were posted by the case study partners prior to the Izmir management board meeting could be considered to have duly "complete" information.

At the same time, it could be anticipated that due to a number of reasons, not all stakeholders that appeared in the database would eventually submit a reply to the Issues Questionnaire. Consequently, the discussion in Izmir on this aspect, focussed on anticipating the number of replies that would be required to allow for the analysis of such replies from a statistical point of view (a preliminary factor analysis was performed on the "test" replies to the questionnaire and documented in the WP01 report).

Planned action: A "standard" letter introducing the OPTIMA project, at the same time inviting to fill out the Water Issues Questionnaire, would be issued to the stakeholders by each of the case study partners. The latter would then follow-up on this by taking up direct contact and the offer to hold face-to-face meetings to guide the filling of the questionnaires.

From a statistical point of view, it was argued that the minimum number of replies should be at least around 70 to merit the application of statistical analysis techniques (see also further below), while it was anticipated that replies for the individual case study areas would be in the range from 5 to 15.

Outcome: More than 200 stakeholders across the 7 case studies received introductory information on the OPTIMA project. The "standard" letter was translated into Arabic (courtesy of CNRS and UoJ), French (CNTD and UH2M) and Greek (Atlantis). (see Appendix 2).

By the agreed deadline, a total of 75 replies – slightly above the minimum target that was set at the Izmir management board meeting - were available for the purpose of performing the planned statistical analysis of the replies to the Water Issues Questionnaire.

3. Summary of findings

Among the main purposes of the statistical analysis, it is possible to distinguish between two complementary aspects:

a) **for each individual case study area**

   whereby the focus of attention is to identify converging as well as diverging (or conflicting) interests among the stakeholders

b) **across the case studies**

   whereby the focus is now to identify similarities as well as dissimilarities between the 7 case studies considered in OPTIMA

The ensuing objectives of this exercise will evidently involve a follow-up on the identification of any "conflicting" demands among the stakeholders in the context of drawing up possible, future 'development scenarios'. Lessons learned from the individual case studies may then be compared with a view to generate broader guidelines for the optimum management of water resources.

To achieve this longer-term objective, it is clearly essential that respondents to the questionnaire have given the same interpretation to the 'issues' presented to them in the questionnaire.

As mentioned earlier, for a statistical analysis to produce meaningful results (e.g. factor analysis) requires that the 'database of replies' is both complete and sufficiently large.

A detailed write-up on the results obtained – using different statistical approaches – is presented in Part II Statistical Analysis of replies to Water Issues Questionnaire. Appropriately, this section starts with an in-depth appraisal of the 'missing' information in the database of replies.

Some of the findings which proved of special interest to guide the socio-economic framework analysis presented in Part III are briefly summarized here.

The statistical analysis was performed on a dataset consisting of 75 compiled questionnaires (i.e., those inserted in the OPTIMA on-line database at the end of June 2005), representing the 7 OPTIMA Case Studies.

It is duly noted that due to the relatively small sample size (and the large number of analyzed Issues), it proved necessary to analyze the dataset in its wholeness.

The **distribution of the responses** on the symmetric, 7-point ordinal scale (i.e. from "extremely unimportant" to "extremely important", as well as the two classes of "missing values", for all 64 variables contained in the Questionnaire, reveals that the **respondents tend prevalently to select the "important", "very important" and**

“extremely important” scores of the ordinal scale. Fewer people answered on the “unimportant” branch of the scale.

Four different aggregations of the Stakeholders (by “scope”, by “size”, by “category” and by “type”), were analysed, which showed that **“local” stakeholders generally perceived issues as “less critical”** compared to the ranking assigned by “national” stakeholders, particularly with regard to issues concerning, the “pressure and impact on water demand and quality (mainly related to non-agricultural driving forces)”.

Different types of multivariate analysis techniques, including principal component analysis and cluster analysis, were then used with the objective to identify factors ‘underlying’ the stakeholders’ response to the different issues. In other words, the objective of the statistical analysis is to extract a much more reduced set of factors which replicate the variation observed in the rankings assigned by the stakeholders to the detailed checklist of issues they were presented with.

Since the multivariate analysis is aimed at removing redundancies in the original dataset, it can be easily understood that these methods prove especially worthwhile the more original variables (ranking assigned to issues by the different stakeholders) are found to be dependent on each other (from a statistical point of view).

The different types of statistical analysis that were performed, consistently identified that the main ‘underlying’ factors could be reduced to the following set of four factors:

“Pressure” and “impact” on water demand and quality, mainly related to non-agricultural “driving forces” (tourism, household, industry).

Deficiencies in the regulatory and institutional “response” (DPSIR Framework), **mainly in relation with Agriculture**;

Techno-economical barriers and (industrial) impact on water quality (limiting its further use due to “too low” quality)

“Subventioned” water price (agriculture and household)
Among the “driving forces” (household, tourism, agriculture and industry), household and agriculture are found

The seven OPTIMA Case Studies are shown to present different scorings on the above 4 factors, basically reflecting the different criticalities and priorities of the investigated watersheds.

It is of course reminded that the available sample size is far less than would be desired, and it was therefore opted to analyse the database of replies in its entirety, based on the assumption that with the heterogeneous survey it should be easier to identify clear factors. Consequently, there was no means to check that the above factors represent a “robust” set of extracted factors that is “generally” applicable.

Despite these reservations on the findings of the statistical analysis, it is reminded that the main aim is a cross-comparison among different Case Studies (and/or different Stakeholders), and that consequently, even the “hint” of a data specific “simpler structure” can be of interest.

Apart from advising on the need for a further increase in the number of compiled questionnaire, the use is suggested of **an independent dataset to validate the results** that were obtained.

There is indeed considerable "proof" presented in Part II 'Statistical analysis of replies to Water Issues Questionnaire' that the latter option may be preferable.

It is observed that stakeholders have tended to give similar ratings to all Tourism related Items (i.e. unimportant if tourism itself is considered un unimportant driving force, important if tourism is considered to be important). This is ascribed to the likelihood of a relatively limited knowledge of the "details" of the impact of Tourism (a secondary driving force).

A most important finding is in connection with the first underlying factor, i.e. "Pressure" and "impact" on water demand and quality, which appears mostly related to non-agricultural "driving forces". Surprisingly, agriculture, the main source of stress in Mediterranean countries, loads only partially on this factor. Agriculture is possibly perceived as an "unavoidable background" present in every basin and tends therefore to emerge only in connection with other more "agriculture specific" Issues, as those included in the 2^{nd} and 4^{th} factors.

While both findings provide a most valuable insight into the perceptions held by stakeholders, these findings suggest that an independent dataset would be needed to arrive at a more scientifically substantiated ranking of the problem issues. Further guidance on how such an independent dataset could be established is presented in Part III of this report.

Appendix 1 Checklist of issues in Water Issues Questionnaire

1. PHYSICAL CONDITIONS

1.1	WATER SCARCITY
1.2	FLOODS
1.3	DROUGHTS
1.4	GROUNDWATER QUANTITY, QUALITY
1.5	WATERSHED DEGRADATION
1.6	COASTAL INTERACTION

2. WATER MANAGEMENT

2.1	INSTITUTIONAL FRAMEWORK
2.1.1	Institutional responsibilities
2.1.2	Active participation
2.1.3	Private sector participation
2.2	REGULATORY FRAMEWORK
2.2.1	Water quality standards, enforcement
2.2.2	Water rights and conflict resolution
2.2.3	Public information access rights
2.3	WATER PRICING POLICIES
2.3.1	Too high, restrictive prices
2.3.2	Too low, no controlling effect
2.3.3	Deficiencies in the tariff structure
2.4	EDUCATION AND AWARENESS
2.5	GENDER ISSUES
2.5.1	Equity in education and training
2.5.2	Women in institutions
2.6	TECHNOLOGY AND INVESTMENTS
2.6.1	Obsolete technologies, maintenance
2.6.2	Techno-economic barriers

3. WATER DEMAND

3.1	HOUSEHOLDS
3.1.1	Water quantity
3.1.1.1	Over-abstraction of surface water
3.1.1.2	Over-pumping of groundwater
3.1.2	Water quality
3.1.2.1	Wastewater from households
3.1.2.2	Uncontrolled solid waste disposal
3.1.2.3	Groundwater contamination (households)
3.1.2.4	Groundwater contamination (waste dumps)
3.1.3	Water saving technologies
3.1.4	Impacts of population growth
3.2	TOURISM
3.2.1	Water quantity
3.2.1.1	Surface water demand by tourism
3.2.1.2	Groundwater demand by tourism
3.2.2	Water quality
3.2.2.1	Surface water pollution by tourism
3.2.2.2	Groundwater pollution by tourism
3.2.3	Water saving technologies
3.2.4	Increasing demands by sectoral growth
3.3	AGRICULTURE
3.3.1	Water quantity
3.3.1.1	Surface water demands
3.3.1.2	Groundwater demands
3.3.2	Water quality
3.3.2.1	Surface water pollution by agriculture
3.3.2.2	Groundwater pollution by agriculture
3.3.3	Water technologies (irrigation efficiency)
3.3.4	Agricultural expansion
3.4	INDUSTRY
3.4.1	Water quantity
3.4.1.1	Surface water use by industry
3.4.1.2	Groundwater extractions by industry
3.4.2	Water quality
3.4.2.1	Surface water pollution by industry
3.4.2.2	Groundwater pollution by industry
3.4.3	Water saving technologies
3.4.4	Impacts of industrial growth
3.5	OTHER USES (environment, shipping, flood control)
3.5.1	Environmental water allocation
3.5.2	Shipping
3.5.3	Flooding

4. WATER SUPPLY

4.1	QUANTITY
4.1.1	Conflicts from limited surface water
4.1.2	Conflicts from limited groundwater
4.1.3	Alternative water resources
4.1.4	Dependency on water imports
4.2	QUALITY
4.2.1	Surface water quality
4.2.2	Groundwater quality
4.2.3	Limits to domestic use
4.2.4	Limits to recreational use
4.2.5	Limits to agricultural use
4.2.6	Limits to industrial use
4.3	INFRASTRUCTURES
4.3.1	Abstraction, reservoirs, water harvesting
4.3.2	Sanitation: sewers and treatment
4.3.3	Distribution losses (canals, pipes)
4.3.4	Preservation of natural resources
4.3.4.1	Impact of infrastructures on biodiversity
4.3.4.2	Prevention of natural disasters

Appendix 2 'Standard' letter issued to stakeholders by respective case study partners (English, French, Arabic and Greek)

To the attention of
<Name of person>
<Organisation>
<Address>

<Date>

Subject: OPTIMA: Optimisation for Sustainable Water Resources Management

Dear <Name of person>

We take pleasure to inform you of our participation in OPTIMA, an EU sponsored three year research project which started on 1st July 2004 and which brings together researchers from 11 countries in the Euro-Mediterranean area. The overall aim of the project is to develop, test, and critically evaluate an innovative approach to water resources management in the Mediterranean region.

The results of the project should contribute to increased efficiency and to reconcile conflicting demands. While the OPTIMA approach is based on rigorous, scientifically sound concepts, the highest importance will be given to achieve results that can be implemented in a practical manner. In this regard, we duly recognize that a successful implementation will ultimately depend on the acceptance by the whole chain of stakeholders involved with the decision-making level, planning, production and distribution … up to the various end-users (domestic, agriculture, industry, tourism etc.).

We would like to invite your organization to assist us in achieving these goals by sending us your feedback during all stages of our research efforts. For a detailed description of the project, case studies and partners in OPTIMA, you may wish to visit the website http://www.ess.co.at/OPTIMA/. Among the progress achieved so far, you may wish to consult the on-line database of major actors and stakeholders, identified to-date in each of the seven case study areas where the OPTIMA methodology will be applied (see http://www.ess.co.at/OPTIMA/cases.html). To further extend this on-line database, we would welcome to receive a brief description on the scope, mission statement, and any other information you may wish to provide about of your organization.

During the first year of our research we are keen to obtain a concise and clear overview of the water issues as relevant to our mutual case study area. For this reason, we are enclosing a comprehensive list of water issues. We would appreciate if you kindly fill out the attached questionnaire and return it to us by 15 March 2005.

Thank you for your co-operation and we look forward to keep you up-to-date on the progress with the OPTIMA research project

Yours Sincerely

A l'attention de
<Nom de la personne>
<Organisation>
<Adresse>

<Date>

Objet: OPTIMA: Optimisation de la gestion durable des ressources en eau

Cher Monsieur, Madame

Nous avons le plaisir de vous informer de notre participation au projet OPTIMA, un projet de recherche financé par la Communauté Européenne. Ce projet, de 3 ans de durée, a débuté le 1er Juillet 2004 et rassemble des chercheurs de 11 pays Euro-Méditerranéens. L'objectif du projet est de développer, tester et évaluer une nouvelle approche de gestion des ressources en eau dans la région méditerranéenne.

Les résultats du projet devraient contribuer à réconcilier les demandes conflictuelles sur les ressources en eau. L'approche du projet OPTIMA est basée sur un concept scientifiquement rigoureux. L'accent est mis sur l'implémentation pratique des résultats. Cette implémentation ne peut être réellement efficace que grâce à l'implication effective des différents protagonistes nationaux impliqués dans les processus de décision, de production ou de distribution, ainsi que celle des utilisateurs finaux de la ressource (usages domestique, agricole, industriel, touristique …).

Nous sollicitons votre institution afin de nous aider à réaliser les objectifs du projet OPTIMA et ce, en nous faisant part de vos réactions et de vos remarques à propos des différentes étapes du projet. Pour une description détaillée du projet, des différentes études de cas et des différents partenaires, nous vous invitons à visiter le site Web http://www.ess.co.at/OPTIMA/. Parmi les progrès réalisés jusqu'à maintenant, vous pouvez consulter on-line la base de données relative aux principaux acteurs identifiés pour chacun des cas d'étude au niveau desquels la méthodologie du projet OPTIMA sera appliquée. (Voir http://www.ess.co.at/OPTIMA/cases.html).
Dans le but d'enrichir cette base de données nous vous invitons à consulter les données relatives à votre institution et d'y apporter toute modification que vous jugez utile et pertinente.

Durant la première année de la recherche, nous comptons obtenir une vue globale sur la problématique de l'eau au niveau des 7 cas d'étude. Pour ce faire nous sommes entrain de finaliser une liste exhaustive des différentes problématiques de l'utilisation de l'eau. Nous vous saurions gré de remplir le questionnaire ci-joint et nous le retourner au plus tard le 15 mars 2005.

Nous vous remercions de votre coopération et nous vous tiendrons au courant de l'avancement du projet.

Salutations distinguées.

مسودّة الرسالة إلى المعنيين بالأمر (stakeholders)

تاريخ

لجان ب

الموضوع : مشروع OPTIMA ترشيد الإدارة المستدامة لموارد المياه

تحيّة طيّبة،

يسرّنا أن نعلمكم عن مشاركتنا في مشروع "OPTIMA" الذي تموّله السوق الأوروبية لثالث سنوات، وقد بدأ منذ أوائل تموز (يوليو) 2004، ويشترك فيه باحثون من 11 بلدًا أورو-متوسطي. يهدف المشروع لتطوير وتقويم سُبُل رائدة لإدارة موارد المياه في منطقة المتوسط.

نتوقع أن تساهم نتائج المشروع في زيادة فعالية معالجة مشاكل الطلب على المياه. فبينما يعتمد المشروع على مفاهيم علمية دقيقة، ستكون الأهمية بالتركيز على نتائج يمكن تنفيذها بطرق ملموسة. ونعتبر، انطلاقًا من ذلك، أن التنفيذ الناجح مرهون بملاءمة طروحات المشروع مع تطلّعات المعنيين بالأمر في كافة المستويات: أيّ التخطيط، والقرار، والإنتاج، والتوزيع، وإلى المستهلك في كافة القطاعات.

من هنا، نتمنّى على مؤسستكم مساعدتنا في تحقيق ما تقدّم عبر تعاونكم في تأمين معلومات خلال قيامنا بمراحل المشروع المختلفة. ويمكنكم الإطلاع على تفاصيل المشروع و دراسة الحالات بالدول المتوسطية فيه والشركاء بزيارتكم العنوان الإلكتروني:
http://www.ess.co.at/OPTIMA/
كما يمكنكم الإطلاع على تقدّم العمل بالمشروع والمعلومات عن "الحالات الدراسية" الخاصة فيه (في البلدان المتوسطية المشتركة) والمعنيين بالأمر المعرَّف عنهم بزيارتكم العنوان الإلكتروني:
http://www.ess.co.at/OPTIMA/cases.html
ويمكننا توسيع وزيادة المعلومات المتوقرة عن مؤسستكم في إطار أهدافكم وتطلّعاتكم ومعلومات أخرى ذات صلة.

نأخذا فرصة لنؤكّد لكم حرصنا في هذه المرحلة تأمين المعلومات حول شؤون وشجون المياه في "الحالات الدراسية" أعلاه. لذلك تجدون ربطًا لائحة شاملة حول تلك الشؤون المائية. نتمنّى عليكم في ضوء ما تقدّم ملء الاستمارة مساهمة بتعاونكم معنا وإعادتها لنا قبل 15 آذار 2005.

شكرًا لتعاونكم ونأمل أن نبقيكم على اطلاع بمجريات مشروع OPTIMA.

وتفضّلوا بقبول فائق الاحترام والتقدير.

المسؤول

Θέμα: OPTIMA - Βελτιστοποίηση της Αειφόρου Διαχείρισης Υδατικών Πόρων

Σχετικά με το παραπάνω θέμα θα θέλαμε να σας πληροφορήσουμε για τη συμμετοχή μας στο OPTIMA, ένα τριετές ερευνητικό πρόγραμμα επιδοτούμενο από την Ευρωπαϊκή Ένωση, το οποίο ξεκίνησε την 1η Ιουλίου 2004 και μέσω του οποίου έρχονται σε επαφή και συνεργασία ερευνητές από 11 χώρες στην Ευρωπαϊκή – Μεσογειακή περιοχή. Ο ευρύτερος σκοπός του προγράμματος είναι η ανάπτυξη, η δοκιμή και η κριτική αξιολόγηση μιας καινοτομικής προσέγγισης για την διαχείριση υδατικών πόρων στην περιοχή της Μεσογείου, σύμφωνα με τις απαιτήσεις της Οδηγίας 2000/60. Ο σκοπός αυτός επιτυγχάνεται μέσω παράλληλων ερευνητικών δραστηριοτήτων (case studies) στην περιοχή της Μεσογείου. Στην Κύπρο η ερευνητική περιοχή είναι η λεκάνη απορροής του ποταμού Διαρίζου.

Τα αποτελέσματα του προγράμματος στοχεύουν κυρίως στο να συμβάλλουν στη μεγαλύτερη αποδοτικότητα διαχείρισης υδάτινων πόρων και στην συμφιλίωση αντικρουόμενων χρήσεων. Παρόλο που το OPTIMA βασίζεται σε ακριβείς και επιστημονικά έγκυρες έννοιες, θα δοθεί ιδιαίτερη σημασία στην επίτευξη αποτελεσμάτων, τα οποία θα έχουν άμεση πρακτική εφαρμογή κα θα παρέχουν τη δυνατότητα χρήσης τους τόσο από εξειδικευμένους επιστήμονες όσο και από πολιτικά πρόσωπα. Βάσει των αρχών αυτών, αναγνωρίζουμε ότι μία επιτυχής εφαρμογή βασίζεται κυρίως στην αποδοχή και εμπλοκή όλης της αλυσίδας των ενδιαφερόμενων και εμπλεκόμενων στα στάδια της διαδικασίας λήψης αποφάσεων, παραγωγής και διανομής νερού μέχρι και τους διάφορους τελικούς χρήστες σε τομείς όπως οικιακούς, αγροτικούς, βιομηχανικούς, τουριστικούς κλπ.

Για να επιτευχθεί ο στόχος αυτός είναι ιδιαίτερα σημαντικό να επιτύχουμε τη συνεργασία και βοήθεια των εμπλεκόμενων και άλλων ενδιαφερόμενων φορέων. Για το σκοπό αυτό θα θέλαμε να προσκαλέσουμε την εταιρία /οργανισμό σας να υποστηρίξει την ερευνητική εργασία μας, συμβάλλοντας έτσι στην επίτευξη των παραπάνω στόχων.

Για μία λεπτομερή περιγραφή του προγράμματος, των σχετικών ερευνητικών δραστηριοτήτων και των συνεργατών του OPTIMA, μπορείτε να επισκεφτείτε την ιστοσελίδα του έργου, http://www.ess.co.at/OPTIMA/. Επίσης, μπορείτε να συμβουλευτείτε την διαδικτυακή βάση δεδομένων των κυριότερων ενδιαφερόμενων και των εμπλεκόμενων μερίδων που έχουν αναγνωριστεί μέχρι τώρα για κάθε μία από τις εφτά χώρες στις οποίες θα εφαρμοστεί η μεθοδολογία του OPTIMA (βλ. http://www.ess.co.at/OPTIMA/cases.html). Για την περαιτέρω ανάπτυξη αυτής της διαδικτυακής βάσης δεδομένων, θα χαιρόμασταν πολύ να λάβουμε μία σύντομη περιγραφή του αντικειμένου, των στόχων και οποιασδήποτε άλλης πληροφορίας που κρίνετε εσείς σκόπιμο να συμπεριλάβετε για τον οργανισμό/εταιρία σας.

Κατά τη διάρκεια του πρώτου χρόνου της έρευνάς μας, έχουμε ως στόχο να αποκομίσουμε μία συνοπτική και ξεκάθαρη αντίληψη των υδατικών ζητημάτων σχετικών με την ερευνητική μας περιοχή (λεκάνη απορροής του ποταμού Διαρίζου). Γι' αυτόν τον λόγο, επισυνάπτουμε μία ευρεία λίστα με σχετικά υδατικά ζητήματα. Θα εκτιμούσαμε πολύ εάν θα είχατε την καλοσύνη να συμπληρώσετε το επισυναπτόμενο ερωτηματολόγιο και να μας το επιστρέψετε μέχρι της 30 Μαΐου 2005.

Εναλλακτικά είμαστε στη διάθεση σας ούτως ώστε να βοηθήσουμε στη συμπλήρωση του ερωτηματολογίου.

Σας ευχαριστούμε εκ των προτέρων για τη συνεργασία σας και είμαστε στη διάθεση σας για οποιαδήποτε περαιτέρω πληροφορία και ενημέρωση.

Με εκτίμηση,

Part II Statistical analysis of replies to Water Issues Questionnaire

Introduction

In the Framework of the OPTIMA Project, a “Water Issue Questionnaire” - aimed at the investigation of the criticalities in the water supply, demand and management in the different OPTIMA Case Studies - has been prepared. The original form of the Questionnaire was presented in “D01.1 Requirements and Constraints Report”.

Asking questions in the right way requires the evaluators to write sets of Items so that the respondent can easily understand precisely what information must be provided and, with little or no error, can easily provide this information. This means writing questions in a way that facilitates rather than interferes with the respondents’ ability to understand the question and report the answer to the best of their ability. The perception, understanding and comprehensiveness of the Questionnaire presented in D01.1, was therefore initially tested on the OPTIMA participants. Based on the results of this testing phase, a reviewed and revised final form of the Questionnaire was prepared and submitted to selected local Stakeholders.

In the present document, an analysis of the Questionnaires compiled by the selected Stakeholders will be presented. The “Water Issue Survey” data have been analyzed by means of univariate, bivariate and multivariate techniques. The analyzed dataset consists of the scorings assigned by 75 Stakeholders (representative of the seven OPTIMA case studies) to the 64 Issues of the Questionnaire. The scorings were assigned on a symmetric 7-point ordinal scale – consisting of ordered categories ranging from “extremely unimportant” to “extremely important”.

In univariate analysis, the responses to each individual Issue of the Questionnaire are analyzed as if they represented independent data sets. The frequency distributions of the responses to each single Issue can be examined, descriptive statistics and other indicators can be computed and preliminary comparisons between groups of respondents can be made.

In order to explore the presence of relationships between the scorings assigned by the respondents to the different Issues (e.g., if high scorings on one variable are associated with high scoring in another) one has to go beyond univariate analysis, by starting an analysis of the correlations between couples of different Items (bivariate analysis).

However, while an univariate analysis of the different Issues is still manageable (the Questionnaire includes 64 variables) an approach based on an inspection of all possible combinations of variables tends soon to “explode” (64 variables imply more than 2000 independent correlations!). The correlation matrix can still be estimated numerically but its investigation has to be approached by means of appropriate techniques.

Multivariate analysis offers such an opportunity. It proposes a collection of approaches that can be applied when several variables are measured, on each individual, in one or more sample units. As already mentioned, typically, these variables happen to be correlated (if this were not so, one could stop at the univariate level and it would be of no advantage to use a multivariate approach). The main aim of (explorative) multivariate analysis is to untangle the overlapping information provided by the correlated variables and peer beneath the surface to check the existence and consequently “discover” any “underlying structure”. Thus the main goal of most explorative multivariate techniques becomes just a simplification of the set of the original data, by seeking to express what is going on in terms of a reduced set of new dimensions (whose meaning can be possibly interpreted).

The Deliverable is structures on 4 main Sections: Section 0, introduces the analysis and treatment of ordinal variables and missing values (imputation). Section 0 gives an overview of the interviewed Stakeholders, while the results of univariate and multivariate analysis are presented, respectively, in Section 0 and 0.

Data Preprocessing

The treatment of ordinal variables

The Water Issue Questionnaire is based on the use of a 7-point symmetric ordinal scale, anchored to: "Extremely Unimportant" and "Extremely Important" (the intermediate ratings, when necessary, have been labelled as "Very Unimportant", "Unimportant", "Neutral", "Important", "Very Important", respectively).

Any analysis of the colleted data would therefore be limited by the lack of a precise (i.e., continuous) measurement. The following questions can, e.g., arise: is a "Very Important" Issue twice as important as an "Important" Issue? Is the difference between "Extremely Important" and "Very Important" comparable to the difference between "Neutral" and "Unimportant"? Somehow, the 7-point ordinal scale offers only a limited measure of relevancy of a specific Item, that only allows us to establish a general rank ordering. This general measurement topic is usually discussed in statistics in terms of types of measurement or scale of measurement. Without going into too much detail, most common statistical techniques assume that the underlying measurements are at least of interval quality, meaning that equally spaced intervals on the scale can be compared in a meaningful manner (e.g., "Extremely Important" minus "Very Important" equal to "Neutral" minus "Unimportant"). However, as in our example, this assumption can be questionable, the data rather represent a rank ordering of observations rather than precise measurements. A consistent analysis of the survey results should rely on estimation procedures appropriate to the ordinality of the data. This brings to the application of rather advanced and "relatively non standard" procedures.

Although the aforementioned limits are well known, it is however a relatively simpler and common praxis to assign integer scores (e.g., 1,2,3,…) to the ordinal variables and treat them as if they had metric properties. It has been empirically observed that, especially when the number of categories is large, the failure to address ordinality of the data is likely negligible (e.g., it has been found that many multivariate techniques give reliable results even when applied to ordinal data /1/). Indeed, Bentler & Chou have argued that, given normally distributed ordinal variables, "*continuous methods can be used with little worry when a variable has four or more categories*" (/2/, p. 88).

In analyzing the data we have therefore implemented two alternative approaches: the first one aimed at a more consistent treatment of the lack of precise measurements (as a consequence of the ordinality of the variables), the second one using the straightforward replacement of ordinal categories with integer numbers (e.g., from 1 to 7) and applying traditional statistical methods as if the variables were continuous.

As verified in a "post analysis", the two approaches tend generally to bring to substantially equivalent results, at least for the aims of our study and with reference to the limited quantity and quality of the available data.

While the multivariate methods for continuous variables are traditionally employed and therefore "well known in literature", in this Section we briefly present an approach aimed at a "more consistent" analysis of ordinal variables. This kind of analysis is described in details by Jöreskog (e.g., /3/) and implemented in the software package LISREL (or, better said, in its pre-processor PRELIS).

The main idea is that, to each ordinal variable, is associated an *underlying* continuous variable. This continuous variable represent the attitude underlying the ordered responses and is assumed to have a range from $-\infty$ to $+\infty$. It is this underlying variable that will be then used in the statistical analysis, not the directly measured ordinal variable. The underlying variable, z^*, therefore is used to assign a metric to the ordinal variable, z. In our case of 7 ordinal categories - labelled, for simplicity, 1, 2, . . . , 7 - the connection between the two variables is:

$$z = i \iff \tau_{i-1} < z^* < \tau_i, \qquad i = 1, 2, \ldots, 7,$$

where $-\infty = \tau_0 < \tau_1 < \tau_2 < \ldots < \tau_6 < \tau_7 = +\infty$, are parameters also known as "threshold values". With 7 categories, there are therefore 6 threshold parameters $\tau_1, \tau_2, \ldots, \tau_6$ to be defined.

Because only ordinal information is available, the distribution of z* is determined only up to a monotonic transformation. By using a standard normal distributions, the threshold values can be evaluated, for each z*, from the proportions of cases responding to each ordinal category /3/. On the other side, in the threshold are fixed in advance, the derived underlying normal distributions can be used to estimate the mean and standard deviation of the underlying distribution. Focussing on the underlying variables, one could therefore talk of normal distributions, derive estimations for the means and standard deviations and use these quantities to compare the scoring of different Issues or Stakeholders, see Section 0. These concepts would instead be inapplicable (and meaningless) at the level of the ordinal variables themselves.

Furthermore, if for each pair of z* an underlying bivariate normal is assumed (the validity of this assumption can be tested, at least, if the sample is not too small), a correlation coefficient, known as *polychoric correlation*, can consistently be estimated for the underlying variables /3/. Multivariate analysis techniques can then be applied to this *polychoric correlation* matrix. In case of factor analysis, a factoring method particular suitable to a more consistent treatment of ordinal variables, is MINRES (MINimum RESiduals, based on unweighted least squares). The main characteristic of this method is that it doesn't require any distributional assumptions, and that it can be used with relatively small samples even when the number of variables is large and when the correlation matrix is not positive definite (as it might be the case for a matrix of polychoric correlations) /4/.

Results obtained through MINRES factoring of the polychoric correlation matrix are presented in Section 0 (and found to be, at least for our aims, substantially "equivalent" to the "much straightforward" standard solution obtained by simply substituting the ordinal variable by an integer scale and treating it as a continuous variable, although its lack of consistency from a formal point of view).

Analysis of missing values

As normal praxis in the analysis of surveys, several not quantified values (on the symmetric 7-point ordinal scale, consisting of ordered responses ranging from "extremely unimportant" to "extremely important") were present in the collected data (see Figure 1). In order to help in their interpretation, two different classes of missing values can be introduced:

- the first category includes those Issue where the answer "don't know" was selected. This could happen, e.g., when the interviewed perceived himself/herself "incompetent" on that specific Item or when the question (or its formulation) was found to be not sufficiently understandable;
- the second category includes those cases where no answer was assigned to the Item. This could happen in case the data was already not available "at the source" (e.g., when the interviewed refused to give an answer, the interviewer didn't fill the questionnaire in a proper way) or when, for any reason, the answer went lost in one of the several steps bringing from "raw" to "end user" data of checked quality (i.e., the one distributed on the OPTIMA web page - at the address: http://www.ess.co.at/OPTIMA/issues.html).

Obviously, the responses "don't know" and "no answer" cannot be used as categories for the ordinal scale that goes from "extremely unimportant" to "extremely important".

The usual way to deal with such responses is to declare them as *missing values* and include some treatment of missing values in the pre-analysis.

The dataset analyzed in the present Deliverable consists of 75 compiled questionnaires (i.e., those inserted in the OPTIMA on-line database at the end of June 2005), representing the 7 OPTIMA Case Studies. The distribution of the responses on the 7-point ordinal scale, as well as the two classes of "missing values", for all 64 variables contained in the Questionnaire, is shown in Figure 1. One can notice as the respondents tend prevalently to select the "important", "very important" and "extremely important" scores of the ordinal scale. Fewer people answered on the "unimportant" branch of the scale.

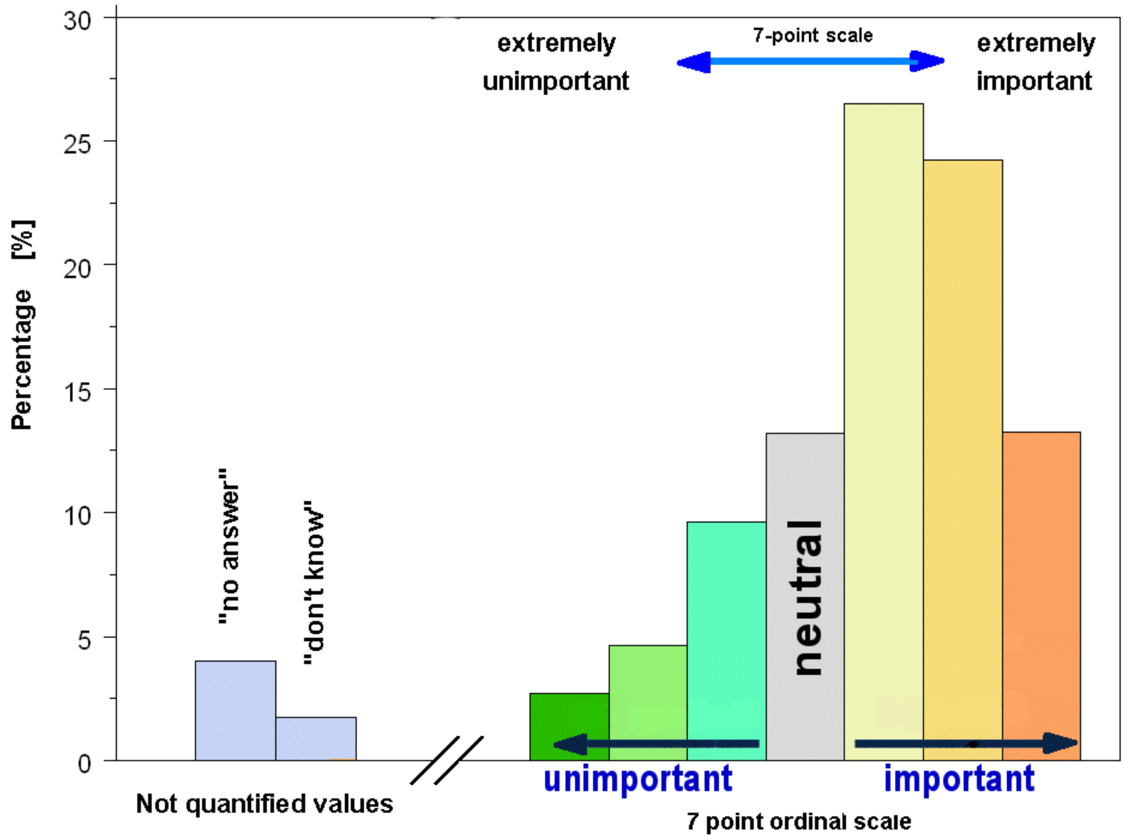

Figure 1 Percentage distribution of the responses to the 75 compiled questionnaires for the 7 OPTIMA case studies

The first step towards the statistical analysis of the "Water Issue Questionnaires", was the investigation of the quantity and pattern of missing data. The detailed results are reported in Table 13 (in the Appendix), that shows, for each Issue, the number and percentage of missing values (distinguishing between "don't know" and "non available" answers). The total number and percentage of "missing values" are reported in the following Table (the analyzed dataset consists of 75 questionnaires of 64 items each, i.e., 4800 entries).

Entries as "don't know"	"missing values"	Total "not quantified"
85 (1.8%)	194 (4.0%)	199 (5.8%)

Table 1 Total number (and percentage) of "missing values" met in the analysis of the 75 available questionnaires. The first column corresponds to answer classified as "don't know", the second column to "empty entries" (no value at all associated to the item). The last column (the sum of the previous two) represents the number (and percentage) of answer not classified on the symmetric 7-point ordinal scale (ranging from "extremely unimportant" to "extremely important")

Although the total number of "not quantified" answers is relatively low (5.8% - dominated by "missing values", i.e., empty entries), 58 variables out of 64, as well as 47 questionnaires out of 75, present at least one of these values (i.e., at lest one "not quantified" value is contained in 91% of the variables and 63% of the questionnaires to be analyzed).

Apart from the total number (and its disaggregation for each single Item, see Table 13, in Appendix), it is important to investigate the distribution of "not quantified" answers in order to identify eventual patterns. The discovery of patterns of missing data can be facilitated by grouping together similar questionnaire Issues (variables) and questionnaire respondents (observations). An example is shown in Figure 2, where the Issues (columns) and respondents (rows) have been rearranged according to the number and patterns of "not quantified" data (i.e., both "don't know" and "missing" answers). In the figure the following colour code is used: in black are represented the “non quantified entries”, while in green those Issues for which the respondent has given an answer quantified on the 7-point ordinal scale.

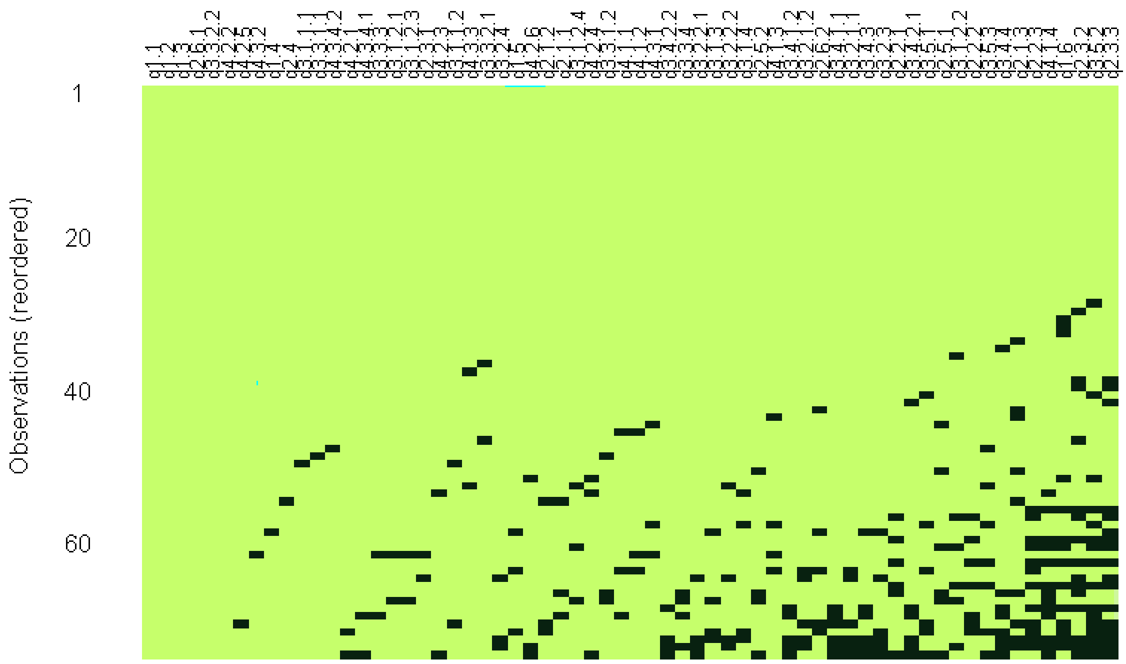

Figure 2 the black pattern reflects the structure of "not quantified" values (i.e., both "don't know" and "missing" answers). Both the Issues (columns) as well as the respondent to the Questionnaire (rows) have been re-ordered

One can see, as already noticed, that the "not quantified" entries correspond to a relatively sparse minority. The graphical representation of Figure 2, tends to concentrate the most critical cases in the bottom right of the Figure. Some of the questionnaires contain a considerable amount of "not quantified" entries and some of the investigated Items result to be "more critical" than others (i.e., they tend to present a higher amount of "don't know" or "missing" entries) Furthermore, Figure 2 tends to highlight the presence of patterns of "not quantified" entries (i.e., if a "missing" entry is found on one specific Item of the questionnaire, other "missing" entries tend to be present on other correlated Items). This is the meaning of the "horizontal black segments" observed especially on the bottom right of Figure 2,

It is worth to highlight some of the most critical cases. The most critical Items of the questionnaire (with respect to the fraction of "not quantified" entries) are reported in Table 2 (in decreasing order of "not quantified" answers, see also Table 13, for the complete list). These Issues are the ones plotted as the last columns on the right in Figure 2.

Code	Class	Water Issue	"don't know"	"missing values"	Total "not quantified"
2.3.3	WATER MANAGEMENT	WATER PRICING POLICIES - Deficiencies in the tariff structure	2 (2.7%)	15 (20.0%)	17 (22.7%)
3.5.2	WATER DEMAND	OTHER USES (environment, shipping, flood control) - Shipping	6 (8.0%)	10 (13.3%)	16 (21.3%)
2.3.2	WATER MANAGEMENT	WATER PRICING POLICIES - Too low, no controlling effect	2 (2.7%)	13 (17.3%)	15 (20.0%)
1.6	PHYSICAL CONDITIONS	COASTAL INTERACTION	8 (10.7%)	6 (8.0%)	14 (18.7%)
4.1.4	WATER SUPPLY	QUANTITY - Dependency on water imports	1 (1.3%)	12 (16.0%)	13 (17.3%)
2.2.3	WATER MANAGEMENT	REGULATORY FRAMEWORK - Public information access rights	6 (8.0%)	6 (8.0%)	12 (16.0%)
2.1.3	WATER MANAGEMENT	INSTITUTIONAL FRAMEWORK - Private sector participation	2 (2.7%)	7 (9.3%)	9 (12.0%)

Table 2 most critical Issues, in terms of the total number of "not quantified" entries

One of the most critical Issue is that related to "shipping" (relatively high amount of "don't know" answer), this can partly be due to the fact that the case study basins are mostly non-navigable and the question itself can therefore result rather meaningless. Others are related instead to Issues "too difficult to be answered" (this could also be the consequence of a "too poorly" or "too generally" formulated question). These critical Items are mainly related to water pricing/privatization, public information access right, water imports and coastal interaction.

The rate of "quantified answers" is, however, relatively high for all the investigated Issues (even in the most critical ones, it reaches nearly 80%). A pairwise bivariate analysis shows that the percentage of cases where both Items are quantified reaches nearly 70% even in the most unfortunate combinations of variables (the most critical pairs are "2.1.3 Private sector participation" vs. "2.3.3 Deficiencies in the tariff structure" and "2.3.2 Water Pricing Policies - Too low, no controlling effect" vs. "3.5.2 Shipping", both with 69.3% of cases where both entries have been quantified on the 7-point ordinal scale).

As it emerges from Figure 2, "not quantified" answers are not uniformly distributed among the compiled questionnaires but tend to be concentrated in a subset of relatively "sparsely" compiled ones. While in 57 (out of the 75 compiled questionnaires, available at the time of writing) the fraction of items that received a "non quantitative" answer ("don't know" or "missing") is less than 10%, few questionnaires stand out for their relative large fraction of "non quantitative" answer and are reported in the following Table.

Basin	Stakeholder	"don't know"	"missing values"	Total "not quantified"
Wadi Zeimar	Union of Agricultural Work Center	0 (0%)	23 (35.9%)	23 (35.9%)
Gediz	Electrical Works Authority	17 (26.6%)	5 (7.8%)	22 (34.4%)
Gediz	Ministry of Environment and Forestry	21 (32.8%)	0 (0%)	21 (32.8%)
Litani	Yohmor Municipality	0 (0%)	15 (23.4%)	15 (23.4%)
Litani	Litani tourism	0 (0%)	14 (21.9%)	14 (21.9%)
Martil	Association of the Teachers of Natural science - section of Tetuan	0 (0%)	13 (20.3%)	13 (20.3%)
Gediz	Bank of Provinces	8 (12.5%)	4 (6.3%)	12 (18.8%)
Diarizos	Local community of Nikoklia	0 (0%)	10 (15.6%)	10 (15.6%)
Diarizos	Local Community of Trachipedoula	0 (0%)	10 (15.6%)	10 (15.6%)
Gediz	Sarikiz Irrigation Assoc.	4 (6.3%)	6 (9.4%)	10 (15.6%)

Table 3 most critical Questionnaires in terms of total "not quantified" answers

A global view of the situation is shown in Figure 3, that reports the distribution of the number of "not quantified" Issues contained in the Questionnaires under analysis.

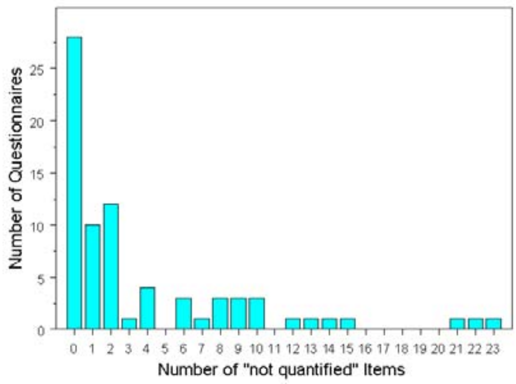

Figure 3 distribution of the number of "not quantified items" (out of the 64 items investigated in each "Water Issue Questionnaire") in the 75 compiled questionnaires presently available for the seven OPTIMA case studies.

Imputation of missing values

As already mentioned, in the analysis of multivariate data, as those at the basis of the "Water Issue Survey", it is not uncommon to have to treat missing measurements.

The most direct option is to simply discard each row that has a missing value (*listwise deletion*). However, with this procedure, even a small portion of missing data, if sparsely distributed, can lead to a substantial loss of data. For example we have noticed in the previous Section that, in our data set with 64 variables (columns) and 75 compiled questionnaires (rows), only about 5.8% of the 64×75=4,800 entries were missing. However, nearly two thirds of the observation vectors (rows) turned out to be incomplete (and all the information would get lost in case of *listwise deletion*). Furthermore, the distribution of missing values in the data set plays an important role. Missing values scattered throughout the data matrix at random, are less serious than a pattern of missing values that depends to some extent on the values of the missing variables themselves. Listwise deletion, for example, relies on the assumption that the pattern of missing values does not depend on the data values (this condition is known as "*missing completely at random*", or MCAR) . Violations of this assumption can lead to biased estimates. Other options have therefore to be considered.

We are mainly interested in the analysis of the correlation (covariance) matrix, focussing on the investigation of an eventual "*simple structure*" (i.e., subgroups of variables and/or respondents that, being highly correlated among them tend to behave as a "single entity" reducing in such a way the dimensionality of the problem, see Section 0). In the estimation of the correlation (covariance) matrix, instead of *listwise* deletion a *pairwise* deletion could be used, i.e., in the evaluation of a specific correlation (covariance) coefficient, only those cases presenting missing values for both or for one of the pair of processed variables will not be used (the number of cases taken into account may therefore differ across coefficients). Pairwise deletion uses as much of the data as possible.

With the aim of having the maximum flexibility in the cross-comparison of the compiled questionnaires we have opted for an imputation of missing values (i.e., "filling the holes" in the data matrix). Several imputation methods are available, the two most common (and rather straightforward) ones are:

- substituting a mean for each missing value, e.g., the average of the available data in the column of the data matrix in which the unknown value lies. Replacing an observation by its mean reduces the variance and the absolute value of the covariance. Therefore, the sample covariance matrix computed from the data matrix with means imputed for missing values is generally biased;
- a regression approach. In its simplest version, the data matrix is partitioned into two parts, one containing all rows with missing entries and the other comprising all the complete rows. Suppose $y_{i,j}$ is the only missing entry in the i^{th} row of Y. Then using the data in the submatrix with complete rows, y_j is regressed on the other variables to obtain a prediction equation. Then the non-missing entries in the i^{th} row are entered as independent variables in the regression equation to obtain the predicted value. The regression method can be improved by iteration. Also this method tends generally to be biased, however, to a lesser extent than the method based on mean substitution.

Both techniques, as well as a "more advanced" EM (expectation-maximization) method, were applied to the data, in order to estimate correlations and covariances and to replace missing values by imputed values. The results (complete matrix composed by original + imputed data) were then submitted to statistical analysis (e.g., factor analysis), finding the results to be fairly independent of the implemented imputation method (due to the relatively small percentage of imputed data, the structure of the correlation/covariance matrix is practically fixed by the "quantified" data, "imputed data" causing only minor corrections). Due to this general "robustness" of the results and taking into account that relatively high correlations are found among subsets of Issues of the Questionnaire, we opted for a regression approach (limiting to two the number of variables to be taken into account in each regression). The results presented in the following Sections refer therefore to a complete data matrix where the original "missing data" were imputed by the regression method.

One has to notice that the regression approach (as well as Pairwise and EM) may still provide good estimates if the data are conditionally missing at random, or MAR (i.e., basically under the assumption that the probability that an observation is missing may depends on the observed data, but not on the missing part of the data). This assumption allows estimates to be adjusted using available information.

However, no approach should be viewed as a "magic black box". While the regression methods allow a specific way in which the values of one variable may be related to another, in the analysis of the results one has to recall which data and variables were substantially affected by "missing values" and therefore are presumably characterized by "higher intrinsic uncertainties"(see, e.g., Table 2 and Table 3). From the other side, as already mentioned, most of the multivariate results depend on the basic structure of the covariance/correlation matrix and this, apart from possibly few pairs of variables (see Section 0), are mainly unaffected by the small percentage of missing values.

General Overview on Stakeholders

Before proceeding with the proper statistical analysis, a first general survey was made on the total number of stakeholders inserted in the project database (see: http://www.ess.co.at/OPTIMA/ADMIN/admin.html, following the link "Stakeholder Data Base") and on those involved in the compilation of the questionnaire, to check whether any bias was applied when eliciting preferences/worries from local actors.

Analyzing single records of the database and comparing institutions among different Case Studies (i.e. different countries) it emerged that, although such institutions should be in principle similar, some not so negligible differences appeared in descriptive fields; this was due to differences in interpretation, by case study partners, of classification of actors belonging to their water basin. For instance, an organization considered of "regional" scope in Turkey is likely to correspond to a "national" one in Cyprus; also classification of "type" depends on national interpretation, for the definition of "Public Authorities" can easily be switched, depending on national way to interpret its meaning, with the "governative organization" one. A probing preliminary check was thus made on apparent mismatches of definition, in search for an overall harmonization of results.

Another elaboration on rough data was performed on the water related categories, i.e. - referring to the definition reported in Deliverable D01.1 ("Requirements and Constraints Report") - an aggregation was performed to increase readability of results, following the criteria stated in the table below. This further aggregation is intended to help the analyst to obtain a sufficient sample when analyzing compiled questionnaires but should also respond a few basic criteria of coherence.

Macro-categories were defined merging those "main categories" that more often appeared coupled in the description of local institutions. In other words: it is more likely to find a local Public Authority taking care of both "management" and "production of freshwater" than one coupling "freshwater" and "soil erosion", while "soil erosion" is usually one the field of study of an NGO also devoted to "aquatic ecosystems".

Anyway this aggregation presented some difficulties, due mostly to partial overlapping of Management&Production and Regulation&Control sets, hopefully solved in the final elaboration.

One last remark should be reported on classification of "collective", or "cooperative" bodies, such as irrigation associations and chambers of commerce and of industry: it emerged how case study partners inclined to define them as "Public Authorities" in many case, and to define their activity in the "Regulation&Control" or "Management&Production" macro-category. Following a different principle, i.e. that those collective bodies are expected to act as interpreters of final users, it was decided to insert them in the "Water Users" macro-category.

<table>
<tr><th>Main Category</th><th>Sub-Category 1</th><th>Sub-Category 2</th><th>Macro-Category</th></tr>
<tr><td colspan="3">water management planning</td><td rowspan="6">Management & Production (MP)</td></tr>
<tr><td rowspan="5">water production</td><td colspan="2">abstraction (freshwater/desalinated) and storage</td></tr>
<tr><td colspan="2">depuration and discharge</td></tr>
<tr><td colspan="2">potable</td></tr>
<tr><td colspan="2">non potable (industrial w.)</td></tr>
<tr><td colspan="2">non potable (irrigation w.)</td></tr>
<tr><td colspan="3">water resources legislation/regulation</td><td rowspan="2">Regulation & Control (RC)</td></tr>
<tr><td colspan="3">water quality and pollution control</td></tr>
<tr><td rowspan="10">water use</td><td colspan="2">light industry</td><td rowspan="13">Water Use (WU)</td></tr>
<tr><td colspan="2">heavy industry</td></tr>
<tr><td colspan="2">hydropower sector</td></tr>
<tr><td colspan="2">household/domestic</td></tr>
<tr><td colspan="2">agriculture: irrigation</td></tr>
<tr><td colspan="2">agriculture: pasture/livestock/aquaculture</td></tr>
<tr><td colspan="2">tourism</td></tr>
<tr><td rowspan="3">services</td><td>public s. (education, health, accommodation)</td></tr>
<tr><td>wholesale and retail sales</td></tr>
<tr><td>transport</td></tr>
<tr><td rowspan="3">non - withdrawal water uses</td><td colspan="2">shipping/navigation</td></tr>
<tr><td colspan="2">fishery</td></tr>
<tr><td colspan="2">recreation</td></tr>
<tr><td rowspan="4">environmental water use</td><td colspan="2">aquatic ecosystem and biodiversity preservation</td><td rowspan="7">Environmental Use (EU)</td></tr>
<tr><td colspan="2">ecological flows in river</td></tr>
<tr><td colspan="2">minimum retention in wetlands</td></tr>
<tr><td colspan="2">other</td></tr>
<tr><td rowspan="3">natural disaster control</td><td colspan="2">flooding</td></tr>
<tr><td colspan="2">soil erosion</td></tr>
<tr><td colspan="2">other</td></tr>
</table>

After the preliminary detailed probe on more than 200 organization, it was possible to proceed with the second step, much faster and leading to first feedbacks on all the first period of the project: it was now possible to compare stakeholders in composition - following the different classification applied - considering the whole set of them or just the subset involved in the questionnaire compilation.

The results are resumed in the following Tables:

Type	Stakeholders filling the questionnaire	Total stakeholders
Commercial (COM)	6	17
Education/Research (EDU)	12	32
Governmental (GOV)	22	67
International organizations (INT_ORG)	2	5
Non-governmental Organizations (NGO)	10	39
Public Authorities (PA)	18	45
Private individuals or groups (PRIV)	5	7
Total	*75*	*212*

Table 4 - Classification for “Type”

Size	Stakeholders filling the questionnaire	Total stakeholders
Very Small	8	12
small	17	48
medium	31	62
large	14	63
very large	5	27
Total	*75*	*212*

Table 5 - Classification for “Size”

Scope	Stakeholders filling the questionnaire	Total stakeholders
Local	25	46
Regional	9	29
National	34	107
International	7	30
Total	*75*	*212*

Table 6 - Classification for “Scope”

Macro-category	Stakeholders filling the questionnaire	Total stakeholders
MP	39	89
RC	2	11
WU	20	52
EU	14	60
Total	*75*	*212*

Table 7 - Classification for “Macro-category “

For a quick overlook on the pattern of the distribution of total and interviewed stakeholders among categories previous data are then represented in the following charts; in all the charts series of data on the foreground represent the “interviewed” stakeholders, while series on the back represent all stakeholders collected in the database (first one refer to 75 stakeholders, second one to 212).

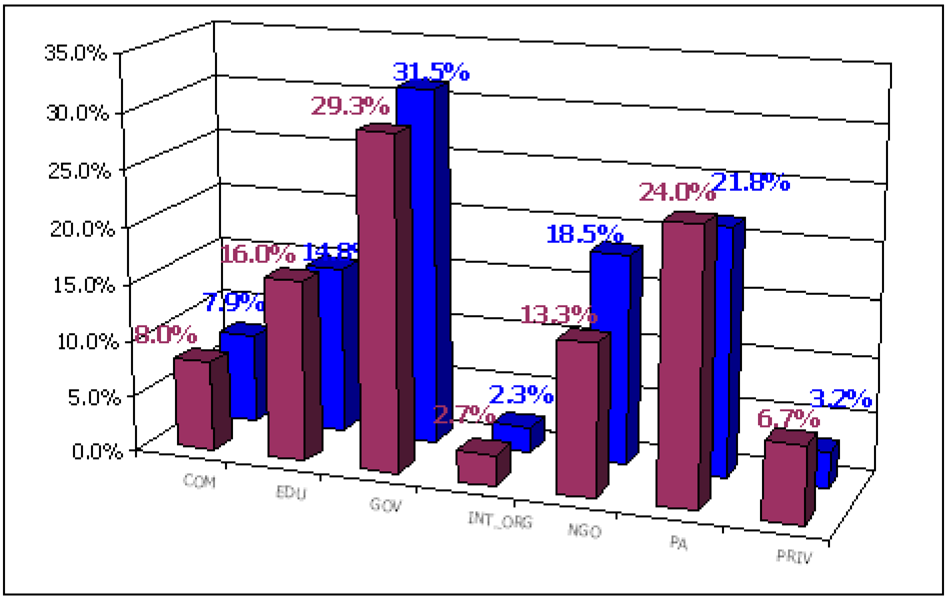

Figure 4 Percentages for "Type" (interviewed and total stakeholders)

While the general distribution of interviewed stakeholders fits quite well the distribution of the totality of them, there's a bigger differentiation in the NGO class: this could be caused by the apparent great number of organizations virtually active in public documents or on the web, that reduces abruptly when a direct contact (for instance for compiling the questionnaire) is seeked. Percentages lost in the NGO class are recovered mostly by PAs and PRIVate individuals.

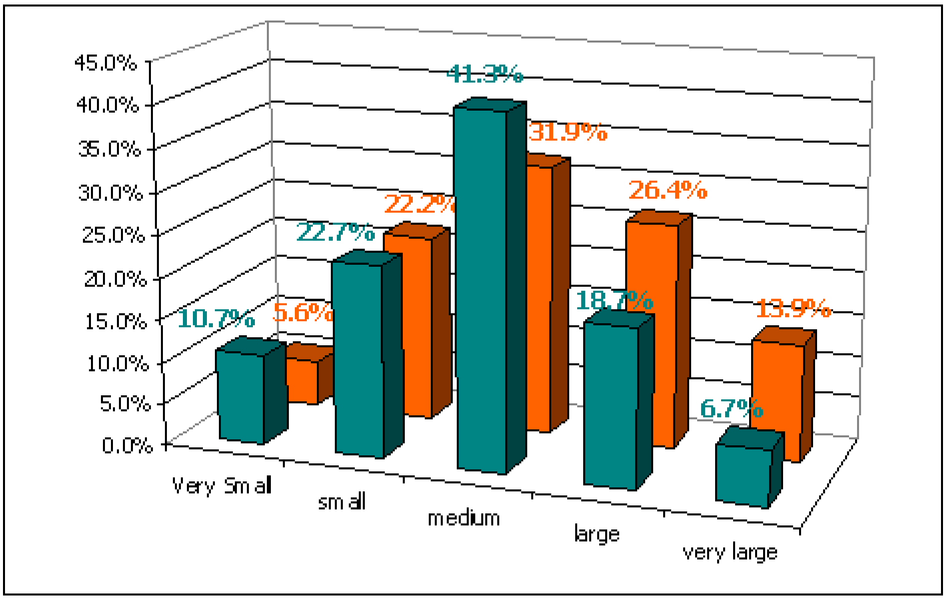

Figure 5 - Percentages for "Size" (interviewed and total stakeholders)

The pattern of the interviewed stakeholders is much steeper compared to the total, and is nearly symmetrical; this should lead to proceed carefully to verify if in many case the "medium" class was chosen as a sort of "neutral" definition, not knowing exactly the measure of "small" and "large". Beyond that, anyway, there's a shift in presence from "large" and "very large" to "small" and "very small"; this can be due to relative difficulty in convincing a Ministry officer to compile a form compared to the same attempt addressed to the member of a local NGO, generally seeking for contacts and a wider audience.

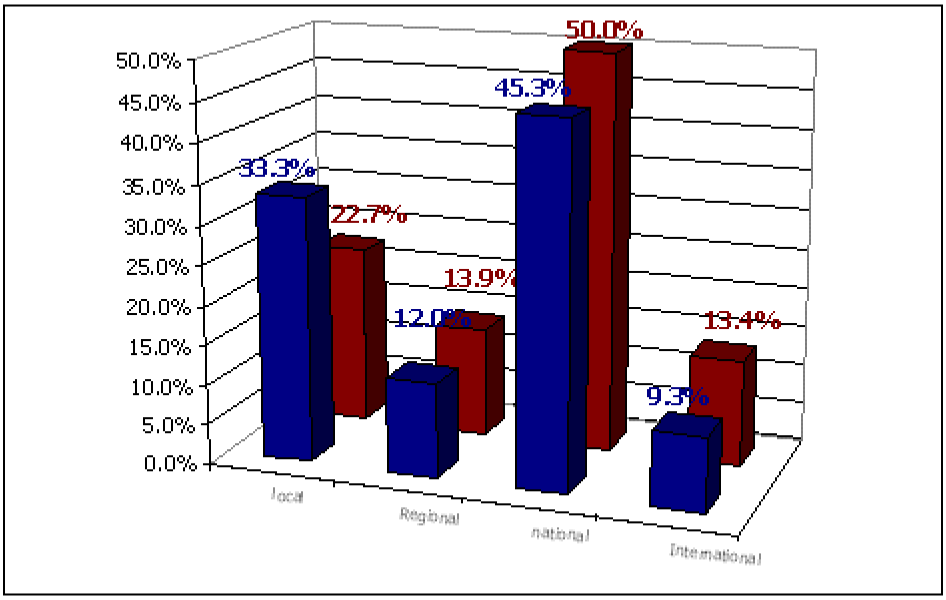

Figure 6 - Percentages for "Scope" (interviewed and total stakeholders)

Concerning "Scope" composition, the distribution among different classes is nearly identical except for the "local" one; as for "Size" composition, this can be due to the relative much bigger accessibility of "local" organization working with a "local" mission; if a further survey confirms that those stakeholders coincide with local NGOs or cooperatives/consortia, this could be explained with the will of such groups to build networks with other local partners for future activities, while usually groups with scopes addressed to wider areas look for partners elsewhere and don't respond promptly as the first.

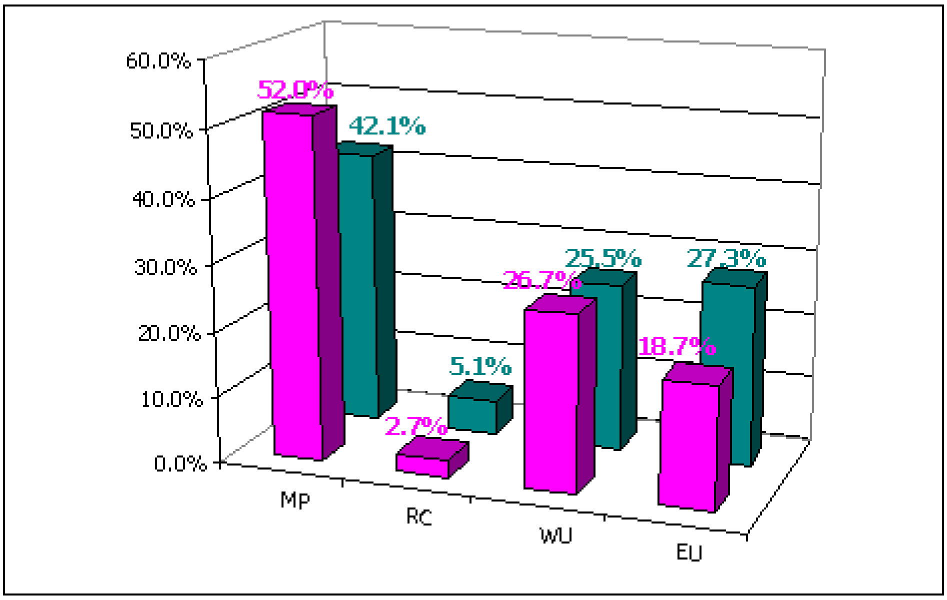

Figure 7 - Percentages for "macro-category" (interviewed and total stakeholders)

The distribution also in this case doesn't differ too much from the "interviewed" stakeholders to the totality of them; the increase in the "Management&Production" class could be explained with the will of local partners to contact institutions directly managing water resources; on the other hand there's and evident unbalance, both for the interviewed and the total stakeholders, between that "Management&Production", category, the "Regulation&Control" one and all the others. This could be due to the relative generic definition of "management", for a lot of universities, research institutes and also private planning offices can fall into this category; some attention should hence be put on this point from now on. On the opposite, bodies able to issue laws and regulations (and officially in charge of take care of controls) are very precisely definite and usually in a extremely reduced number (one ministry, one agency to check water quality and little more...).

A general conclusion that can be issued by this preliminary survey is that, in spite of some minor aspects to be checked and corrected in the methodology so far followed, a good correspondence is found between composition of the interviewed stakeholders and the overall ones listed in the database. This means that great attention was put by local partners, beyond differences in interpretation of some specific definitions, to extract from the set of stakeholders they created in the previous phase of the project a correspondingly homogeneous subset of institution to give feedbacks on water issue through the questionnaire.

Item Respones and Univariate Analysis

A preliminary statistical analysis was just dedicated to the identification of the Questionnaire Items that were scored as “most important” in the different water basins. The objective was to compare different characteristics across groups (i.e., the seven different Case Studies).

In order to analyze the ordinal variables, the approach described in Section 0, was implemented. The underlying continuous unobserved variables z* were treated as normal distributions. With the objective of a cross-comparison among the different Case Studies, following the procedure implemented by Jöreskog in Section 4 of /3/, the set of thresholds for each variable was fixed to be the same in each Case Study. Since the underlying variables are only determined up to a monotonic transformation, following the procedure in /3/, one can simply choose these fixed thresholds as 0, 1, 2, … for all variables[1]. Alternatively, one could estimate a set of thresholds from the total sample by pooling the data from all groups into a single dataset. Either way, these thresholds define a scale for the underlying variables common to all groups.

Using the thresholds as fixed thresholds, one can then estimate the means and the standard deviations of the underlying variables z*, for each group (e.g., Case Study). These means and standard deviations (as well as other statistical quantities as, e.g., the covariance *polychoric* matrix, see Section 0) can then be used in further analysis, as if the underlying variables had been observed. However, in the present application, one has to take the results with some care, as, due to the relatively small number of available compiled Questionnaires (especially once they are further disaggregated on the seven Case Studies), the determination of both the mean and standard deviation (as well as the correlation/covariance) would come along with a considerable level of uncertainty.

The numerical values of the means and standard deviations, derived by the implementation of the previously explained procedure, are reported in Table 8 (for those Issues that will be used in the multivariate analysis, see Section 0), while in Figure 8 the mean values are representation graphically.

Water Issues	Cyprus	Turkey	Lebanon	Morocco	Tunisia	Palestine Israel	Jordan
INSTITUTIONAL FRAMEWORK – Institutional responsibilities	4.13 (0.78)	6.03 (1.04)	3.77 (1.04)	2.42 (0.66)	3.45 (0.47)	3.37 (0.46)	3.65 (0.81)
INSTITUTIONAL FRAMEWORK – Active participation	4.55 (0.77)	5.34 (0.98)	3.42 (0.95)	1.47 (1.00)	3.03 (0.58)	3.14 (0.52)	3.64 (0.79)

[1] we believe this choice to be “discretionary” (as the non-metric ordinal scale represents a rank ordering of observations, rather than precise measurements, there will always be a “subjective” choice when translating the information available on an ordinal to a metric scale, see Section 0). The choice of fixed equidistant thresholds seems, however, the most appropriate for the “Extremely unimportant”-“Extremely important” anchored scale at the base of the “Water Issue Questionnaire”. Furthermore, after having tested few not equidistant threshold intervals, we can state that the general conclusions from a cross-comparison of the Item scoring on different Case Studies, are relatively independent from a (reasonable) choice of the fixed threshold.

INSTITUTIONAL FRAMEWORK - Private sector participation	3.07 (0.51)	2.36 (1.62)	2.98 (1.82)	2.14 (0.83)	2.58 (0.49)	2.94 (0.58)	2.97 (0.58)
REGULATORY FRAMEWORK - Water quality standards, enforcement	3.51 (0.78)	3.92 (0.75)	3.66 (1.78)	2.34 (0.65)	3.28 (0.53)	4.42 (0.75)	3.93 (0.73)
REGULATORY FRAMEWORK - Water rights and conflict resolution	4.21 (0.81)	3.94 (0.89)	3.96 (0.89)	2.78 (0.57)	3.49 (0.47)	5.65 (0.94)	3.63 (0.81)
REGULATORY FRAMEWORK - Public information access rights	2.82 (0.44)	3.47 (0.76)	3.60 (0.93)	4.53 (0.77)	5.22 (0.83)	3.92 (0.89)	3.34 (0.46)
WATER PRICING POLICIES - Too high, restrictive prices	4.05 (0.92)	3.47 (0.78)	2.91 (1.86)	3.07 (0.67)	4.06 (0.78)	4.11 (0.67)	2.87 (0.57)
WATER PRICING POLICIES - Too low, no controlling effect	2.61 (0.65)	3.77 (0.71)	3.67 (0.83)	2.86 (0.57)	3.41 (0.47)	3.18 (0.52)	3.19 (0.52)
WATER PRICING POLICIES - Deficiencies in the tariff structure	3.83 (0.59)	4.04 (1.90)	3.60 (1.02)	2.88 (0.57)	2.65 (0.64)	4.51 (0.76)	4.35 (0.73)
EDUCATION AND AWARENESS	3.95 (0.62)	5.78 (1.10)	3.68 (1.03)	3.03 (0.58)	6.37 (1.12)	3.18 (0.52)	3.79 (0.83)
GENDER ISSUES - Equity in education and training	1.75 (0.92)	4.48 (1.02)	2.26 (1.67)	2.50 (0.64)	4.51 (0.76)	2.78 (0.57)	2.55 (0.65)
GENDER ISSUES - Women in institutions	2.41 (0.49)	1.56 (0.98)	2.93 (0.86)	2.61 (0.64)	4.42 (0.74)	3.10 (0.51)	3.35 (0.74)
TECHNOLOGY AND INVESTMENTS - Obsolete technologies, maintenance	2.63 (0.49)	3.82 (0.72)	3.87 (0.72)	2.91 (0.58)	4.16 (0.80)	3.23 (0.53)	2.92 (0.57)
TECHNOLOGY AND INVESTMENTS - Techno-economic barriers	2.85 (0.57)	3.81 (0.72)	4.05 (0.78)	3.24 (0.53)	3.18 (0.52)	3.19 (0.53)	3.95 (0.74)
HOUSEHOLDS - Water quantity - Over-abstraction of surface water	2.83 (0.57)	3.78 (0.71)	3.77 (0.85)	3.33 (0.46)	3.45 (0.47)	3.31 (0.95)	3.83 (2.10)
HOUSEHOLDS - Water quantity - Over-pumping of groundwater	2.76 (0.57)	4.37 (0.85)	4.44 (0.76)	3.27 (0.53)	3.41 (0.47)	4.14 (0.94)	6.81 (1.24)
HOUSEHOLDS - Water quality - Wastewater from households	3.12 (0.68)	2.99 (0.87)	4.40 (0.74)	3.45 (0.47)	3.45 (0.47)	3.14 (0.52)	3.83 (0.86)
HOUSEHOLDS - Water quality - Uncontrolled solid waste disposal	2.09 (0.85)	3.32 (0.74)	3.76 (1.05)	3.43 (0.47)	3.41 (0.47)	4.58 (0.79)	3.28 (2.16)
HOUSEHOLDS - Water quality - Groundwater contamination (households)	2.47 (0.65)	2.78 (0.82)	4.06 (0.91)	3.33 (0.46)	3.45 (0.47)	4.24 (0.70)	3.96 (0.89)
HOUSEHOLDS - Water quality - Groundwater contamination (waste dumps)	2.86 (0.57)	2.77 (0.81)	4.27 (0.82)	3.31 (0.53)	3.41 (0.47)	4.36 (0.73)	3.91 (0.87)
HOUSEHOLDS - Water saving technologies	2.94 (0.58)	2.77 (0.57)	3.60 (0.81)	4.42 (0.73)	4.77 (0.83)	3.79 (0.85)	4.70 (0.82)
HOUSEHOLDS - Impacts of population growth	1.49 (0.97)	2.14 (0.63)	4.19 (0.95)	4.62 (0.90)	3.49 (0.47)	4.88 (0.75)	5.03 (0.89)
TOURISM - Water quantity - Surface water demand by tourism	2.07 (0.59)	0.91 (1.14)	2.37 (0.79)	3.28 (0.72)	5.22 (0.83)	3.19 (0.53)	3.59 (0.80)
TOURISM - Water quantity - Groundwater demand by tourism	1.64 (0.52)	0.38 (0.92)	2.23 (0.83)	2.81 (0.57)	4.88 (0.74)	4.16 (0.80)	3.77 (0.70)
TOURISM - Water quality - Surface water pollution by tourism	0.80 (0.80)	0.84 (0.94)	2.25 (0.82)	2.86 (0.57)	4.77 (0.83)	3.14 (0.52)	2.79 (0.57)
TOURISM - Water quality - Groundwater pollution by tourism	0.80 (0.80)	0.97 (1.12)	2.51 (1.67)	2.86 (0.57)	4.77 (0.83)	4.06 (0.78)	3.13 (0.52)
TOURISM - Water saving technologies	1.10 (0.86)	-1.26 (4.28)	3.34 (1.70)	4.03 (0.76)	4.54 (0.66)	4.36 (0.73)	3.98 (0.75)
TOURISM - Increasing demands by sectoral growth	2.21 (0.64)	0.51 (0.89)	2.35 (0.80)	3.44 (0.76)	3.49 (0.47)	3.32 (0.46)	4.00 (0.75)
AGRICULTURE - Water quantity - Surface water demands	3.72 (0.83)	5.31 (0.86)	4.50 (2.30)	2.77 (0.57)	4.54 (0.66)	4.24 (0.70)	4.95 (0.87)
AGRICULTURE - Water quantity - Groundwater demands	3.65 (0.81)	5.28 (0.96)	4.18 (1.15)	2.91 (0.57)	4.54 (0.66)	5.22 (0.83)	5.35 (1.09)

AGRICULTURE - Water quality - Surface water pollution by agriculture	2.99 (0.57)	3.72 (1.00)	4.30 (0.97)	2.84 (0.57)	3.45 (0.47)	3.18 (0.52)	4.44 (0.75)
AGRICULTURE - Water quality - Groundwater pollution by agriculture	3.65 (0.81)	3.80 (1.07)	4.12 (0.93)	2.82 (0.57)	3.45 (0.47)	4.76 (0.84)	5.03 (0.89)
AGRICULTURE - Water technologies (irrigation efficiency)	3.58 (0.79)	3.28 (0.53)	4.28 (0.98)	4.68 (0.81)	4.88 (0.74)	3.32 (0.53)	4.13 (0.78)
AGRICULTURE – Agricultural expansion	3.26 (0.72)	2.41 (0.66)	4.37 (1.00)	3.26 (0.72)	3.50 (0.39)	4.58 (0.79)	4.86 (0.85)
INDUSTRY - Water quantity - Surface water use by industry	1.04 (0.86)	2.26 (0.57)	3.37 (0.76)	2.46 (0.49)	3.45 (0.47)	3.74 (0.70)	3.61 (0.66)
INDUSTRY - Water quantity - Groundwater extractions by industry	1.04 (0.86)	2.21 (0.57)	3.26 (0.73)	2.50 (0.50)	3.49 (0.47)	3.84 (0.73)	3.26 (0.52)
INDUSTRY - Water quality - Surface water pollution by industry	1.04 (0.86)	3.05 (0.88)	2.95 (1.62)	2.58 (0.49)	3.50 (0.39)	4.24 (0.70)	4.32 (0.84)
INDUSTRY - Water quality - Groundwater pollution by industry	1.04 (0.86)	2.92 (0.85)	3.25 (0.94)	2.79 (0.44)	3.50 (0.39)	4.51 (0.76)	4.62 (0.92)
INDUSTRY - Water saving technologies	1.89 (0.57)	3.59 (0.80)	3.78 (1.80)	3.92 (0.86)	5.01 (0.89)	5.65 (0.94)	4.28 (0.80)
INDUSTRY - Impacts of industrial growth	1.23 (0.84)	2.84 (0.82)	3.39 (0.76)	3.06 (0.51)	3.28 (0.53)	3.46 (0.96)	3.29 (0.53)
OTHER USES (environment, shipping, flood control) - Environmental water allocation	4.26 (0.70)	4.30 (0.84)	3.56 (1.73)	3.17 (0.51)	3.32 (0.53)	3.03 (0.58)	3.27 (0.92)
OTHER USES (environment, shipping, flood control) - Flooding	1.53 (0.77)	2.35 (0.79)	2.46 (0.77)	3.24 (0.53)	2.71 (0.43)	3.24 (0.53)	1.46 (0.79)
QUANTITY - Conflicts from limited surface water	4.99 (0.89)	4.22 (0.70)	3.82 (1.91)	2.65 (0.55)	4.54 (0.66)	4.49 (0.89)	3.85 (0.72)
QUANTITY - Conflicts from limited groundwater	5.14 (0.93)	4.22 (0.70)	3.42 (0.95)	2.39 (0.49)	3.50 (0.39)	4.95 (0.88)	4.21 (0.81)
QUANTITY - Alternative water resources	3.22 (0.87)	3.57 (0.65)	3.33 (0.75)	3.39 (0.46)	4.34 (0.85)	4.78 (0.83)	4.05 (0.91)
QUANTITY - Dependency on water imports	0.93 (0.77)	0.61 (0.86)	1.91 (0.90)	2.30 (0.65)	3.24 (0.53)	3.15 (0.52)	3.82 (0.86)
QUALITY - Surface water quality	3.04 (0.58)	4.07 (0.66)	3.86 (1.04)	4.13 (0.67)	4.54 (0.66)	3.24 (0.53)	4.32 (0.84)
QUALITY - Groundwater quality	3.63 (0.96)	4.07 (0.66)	4.04 (0.89)	4.16 (0.80)	4.54 (0.66)	5.22 (0.83)	4.53 (1.02)
QUALITY - Limits to domestic use	2.86 (0.57)	3.05 (0.58)	4.07 (0.92)	2.44 (0.64)	3.37 (0.46)	4.22 (0.82)	4.42 (0.86)
QUALITY - Limits to recreational use	0.97 (0.76)	3.10 (0.58)	2.84 (1.45)	2.63 (0.74)	2.66 (0.48)	3.19 (0.53)	2.71 (0.64)
QUALITY - Limits to agricultural use	2.38 (0.65)	4.51 (0.65)	3.16 (1.31)	2.63 (0.74)	3.32 (0.46)	3.07 (0.58)	3.38 (0.75)
QUALITY - Limits to industrial use	1.03 (0.75)	2.73 (0.56)	2.37 (1.31)	2.35 (0.64)	3.32 (0.46)	3.02 (0.58)	3.31 (0.73)
INFRASTRUCTURES - Abstraction, reservoirs, water harvesting	3.52 (0.78)	4.05 (0.78)	3.79 (1.43)	3.21 (0.70)	5.01 (0.89)	4.16 (0.80)	3.42 (0.47)
INFRASTRUCTURES - Sanitation: sewers and treatment	2.60 (0.49)	2.81 (0.57)	4.53 (1.03)	3.04 (0.58)	5.65 (0.94)	4.51 (0.76)	4.03 (0.77)
INFRASTRUCTURES - Distribution losses (canals, pipes)	4.12 (0.92)	2.64 (0.66)	4.93 (0.88)	2.52 (0.65)	3.41 (0.47)	4.49 (0.88)	4.44 (0.75)
INFRASTRUCTURES - Preservation of natural resources - Impact of infrastructures on biodiversity	4.63 (0.92)	1.42 (0.80)	3.98 (0.76)	3.18 (0.68)	3.41 (0.47)	3.11 (0.57)	4.08 (0.92)
INFRASTRUCTURES - Preservation of natural resources - Prevention of natural disasters	2.27 (0.78)	1.73 (0.93)	2.35 (0.80)	2.98 (0.58)	3.32 (0.46)	3.28 (0.53)	2.82 (0.44)

Table 8 Average value and standard deviation (in parenthesis - bottom line) for each water Issue and Case Study (the higher the average the "more important" the Issue tends to be perceived by the respondents). The reported values referred to a "continuous" *underlying* normal distribution, following the procedure implemented by Jöreskog in Section 4 of /3/.

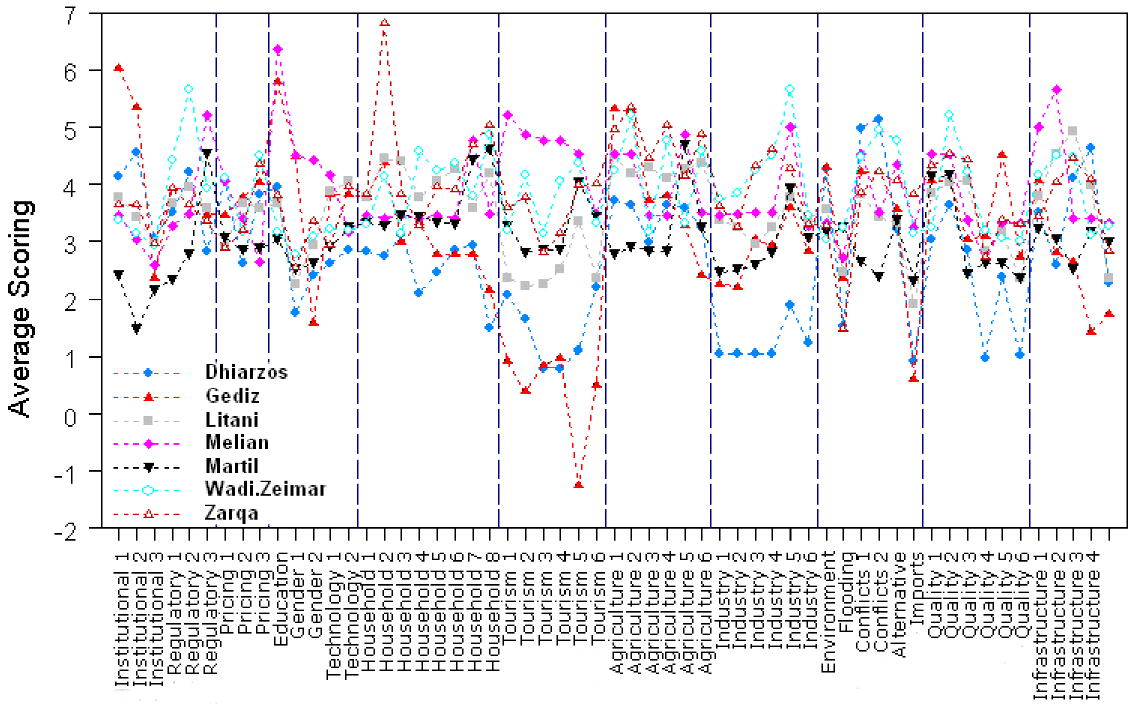

Figure 8 Graphical representation of the average values, reported in Table 8. The presence of "outliers" can be a consequence of the relatively small number of Questionnaires available for the single Case Studies.

Figure 8 shows that the "importance" associated to specific Issues can vary considerably across the different Case Studies (e.g., all Tourism related Issues are judged, on average, to have a "very low priority" by the Gediz and Dhiarzos Stakeholders, but are seen as "main concern" in the Melian Case Study), while for other Issues the judgements seem to be more homogeneous across the different Case Studies (e.g., all three "Water Pricing" related Issues look similarly ranked in all Case Studies).

Apart from this kind of "qualitative visual inspection", the possibility that, for a single Questionnaire Item, the judgements in the seven Case Studies could share a common distribution can be formally tested statistically, e.g., by means of the "Kruskal-Wallis H Test". This test, an extension of the Mann-Whitney U test, is the nonparametric equivalent of a one-way analysis of variance and detects differences in distribution location. As a nonparametric test, "Kruskal-Wallis H Test" should be selected instead of a standard one-way ANOVA in case of ordinal data (in the Kruskal-Wallis model, although homogeneity of variance is still assumed, normality is not).

By applying the test to the scoring on the original 7-point symmetric ordinal scale, we conclude that all Items differ significantly (at the $p<0.01$ level) across the seven Case Studies, apart from the following ones: "Institutional Framework - Private sector participation", "Water Pricing Policies - Too high, restrictive prices", "Water Pricing Policies - Too low, no controlling effect", Water Pricing Policies - Deficiencies in the tariff structure", "Technology and Investments - Obsolete technologies, maintenance", "Technology and Investments - Techno-economic barriers", "Households - Water quantity - Over-abstraction of surface water", "Agriculture - Water technologies (irrigation efficiency)", "Other Uses (environment, shipping, flood control) - Environmental water allocation", "Quality - Surface water quality".

In Figure 8, this Issues have been labelled, respectively, as: "Institutional 3", "Pricing 1", "Pricing 2", "Pricing 3", "Technology 1", "Technology 2", "Household 1", "Agriculture 5", "Environment" and "Quality 1". A visual inspection Figure 8, shows a compatibility with these more formal results.

For each Case Study, by sorting in decreasing order the average values reported in Table 8, we can obtain a potential ranking of the "importance" associated to the single Items (i.e., to the Item with the highest average value would be given a rank equal to 1, and so on). The rank scored by the single Issues, is reported in Table 9, where the Issues have been sorted in order of decreasing average (across the seven Case Studies) rank (i.e., Issues on top are, on average, ranked as "more important" than those coming later). Only those Issues that will be used in multivariate analysis are reported (see Section 0).

Water Issue	Cyprus	Turkey	Lebanon	Morocco	Tunisia	Palestine Israel	Jordan
QUALITY - Groundwater quality	15	12	16	5	12	3	9
AGRICULTURE - Water quantity - Groundwater demands	14	5	11	30	12	3	2
AGRICULTURE - Water quantity - Surface water demands	12	4	3	40	12	19	5
AGRICULTURE - Water technologies (irrigation efficiency)	16	29	8	1	7	35	18
INDUSTRY - Water saving technologies	42	24	23	8	5	1	16
AGRICULTURE - Water quality – gw pollution by agriculture	13	20	12	36	31	8	3
AGRICULTURE - Agricultural expansion	19	42	6	18	23	9	6
HOUSEHOLDS - Water quantity - Over-pumping of gw	31	8	4	17	38	25	1
QUALITY - Surface water quality	23	12	20	6	12	38	14
QUANTITY - Conflicts from limited surface water	2	10	21	41	12	14	28
INFRASTRUCTURES - Sanitation: sewers and treatment	34	36	2	26	2	11	21
HOUSEHOLDS – Impacts of population growth	46	47	10	2	27	6	3
INFRASTRUCTURES - Abstraction, reservoirs,…	17	14	22	21	5	23	39
REG. FRAMEWORK - Water rights and conflict resolution	6	16	18	39	27	1	36
EDUCATION AND AWARENESS	10	2	27	27	1	44	32
QUANTITY - Conflicts from limited groundwater	1	10	35	52	23	5	17
QUANTITY - Alternative water resources	20	25	39	12	20	7	20
HOUSEHOLDS - Water saving technologies	25	39	31	4	9	30	7
INFRASTRUCTURES - Distribution losses (canals, pipes)	8	41	1	46	38	14	10
REG. FRAMEWORK - Public information access rights	30	27	32	3	3	28	42
WATER PRICING - Deficiencies in the tariff structure	11	15	30	31	56	11	13
HOUSEHOLDS - quality - gw contamination (waste dumps)	26	38	9	15	38	17	27
HOUSEHOLDS - quality – gw contamination (households)	35	37	14	13	31	19	24
AGRICULTURE - quality – sw pollution by agriculture	24	23	7	35	31	44	10
HOUSEHOLDS - quality - Wastewater from households	21	33	5	9	31	48	30
INST. FRAMEWORK - Institutional responsibilities	7	1	24	51	31	33	34
HOUSEHOLDS - quantity - Over-abstraction of surface water	29	21	24	13	31	36	29
HOUSEHOLDS - quality - Uncontrolled solid waste disposal	40	28	26	11	38	9	45
QUALITY - Limits to domestic use	26	31	13	50	44	22	12
TECH. AND INVESTMENTS - Techno-economic barriers	28	19	15	20	52	41	25
INFRASTRUCTURES - Impact on biodiversity	3	50	17	22	38	51	19
TOURISM - Water saving technologies	48	57	38	7	12	17	23
INDUSTRY - quality - Groundwater pollution by industry	49	34	41	38	23	11	8
WATER PRICING POLICIES - Too high, restrictive prices	9	26	46	24	22	26	52
REG. FRAMEWORK - Water quality standards, enforcement	18	17	29	54	49	16	26
TECH. AND INV. - Obsolete technologies, maintenance	32	18	19	29	21	40	51
OTHER USES - Environmental water allocation	5	9	33	23	48	54	46
INDUSTRY - quality - Surface water pollution by industry	49	32	44	45	23	19	14
INSTITUTIONAL FRAMEWORK - Active participation	4	3	34	57	53	48	35
TOURISM - Increasing demands by sectoral growth	39	55	53	10	27	34	22
TOURISM - quantity - Surface water demand by tourism	41	52	51	16	3	41	38

WATER PRICING POLICIES - Too low, no controlling effect	33	22	28	32	38	44	48
TOURISM - quantity - Groundwater demand by tourism	44	56	56	37	7	23	33
QUALITY - Limits to agricultural use	37	6	42	42	45	53	40
INDUSTRY - Impacts of industrial growth	47	35	36	25	49	32	44
TOURISM - Water quality - Groundwater pollution by tourism	56	51	48	33	9	27	49
INDUSTRY - quantity - Surface water use by industry	49	45	37	49	31	31	37
GENDER ISSUES - Equity in education and training	43	7	54	48	18	57	56
INDUSTRY - quantity - Groundwater extractions by industry	49	46	40	47	27	29	47
GENDER ISSUES - Women in institutions	36	49	45	44	19	52	41
INFRASTRUCTURES - Prevention of natural disasters	38	48	52	28	45	37	53
OTHER USES flood control	45	44	49	19	54	38	57
TOURISM - quality - Surface water pollution by tourism	56	53	55	33	9	48	54
QUALITY - Limits to recreational use	54	30	47	42	55	41	55
INSTITUTIONAL FRAMEWORK - Private sector participation	22	43	43	56	57	56	50
QUALITY - Limits to industrial use	53	40	50	53	45	55	43
QUANTITY - Dependency on water imports	55	54	57	55	51	47	31

Table 9 Ranks obtained, on the different Case Studies, by each of the 57 Issues that will be used in the multivariate analysis (rank=1 ➔ "most important", rank=57 ➔ "most unimportant"). The Water Issues are ordered in decreasing order of "importance" (taking as reference the average rank scored across all Case Studies).

As could be expected, the most critical Issues are those related to agriculture, water quality (especially groundwater) and Infrastructural/Technological deficiencies. On the other side, Issues related to Tourism, potential limits to the use of water as a consequence of quality degradation and few "social topics" emerge as the one with lowest priority.

The different Case Studies tend to weight the priority of the Water Issues in a different way. This general cross-comparative behaviour can be better investigated by means of multivariate statistical tools.

Multivariate Analysis

Exploratory Factor Analysis

In factor analysis we try to represent the large amount of original variables of the Questionnaire ($y_1, y_2, \ldots, y_p$) as linear combinations of a much smaller new set of variables, called *factors* ($f_1, f_2, \ldots, f_m$ with $m < p$). The factors can be thought as "*underlying constructs*" or "*latent variables*" that "generate" the y's. Like the original variables, the factors vary from individual to individual; but unlike the variables, the factors cannot be measured or observed. The existence of these hypothetical variables is therefore open to question.

If the original variables $y_1, y_2, \ldots, y_p$ are at least moderately correlated, the basic dimensionality of the system is less than p. The goal of factor analysis is to reduce the redundancy among the variables by introducing a smaller number of factors.

Suppose the pattern of the high and low correlations in the correlation matrix is such that the variables in a particular subset have high correlations among themselves but low correlations with all the other variables. Then there may be a single underlying factor that gave rise to the variables in the subset. If the other variables can be similarly grouped into subsets with a like pattern of correlations, then a few factors can represent these groups of variables. In this case the pattern in the correlation matrix corresponds directly to the factors.

For example, suppose, in an "ideal" case, that the correlation matrix looks like:

1.00	.90	.05	.05	.05
.90	1.00	.05	.05	.05
.05	.05	1.00	.90	.90
.05	.05	.90	1.00	.90
.05	.05	.90	.90	1.00

Then the 1st and 2nd variables correspond to a factor, the 3rd, 4th and 5th variables correspond to another independent factor. In some cases where the correlation matrix does not have such a simple pattern, factor analysis will still partition the variables into clusters. The goal of factor analysis is to achieve a "simple structure" in which each variable loads highly on only one factor, with small loadings on all other factors. In practice, one would often fail to achieve this goal, but hopefully could come closer to the desired simple structure.

In contrast with the previous "ideal" case, Rencher portrays the following most "critical" scenario /1/: "*A researcher designs a long questionnaire, with answers to be given in, say, a five-point semantic differential scale or Likert scale. The respondents, who vary in attitude from uninterested to resentful, hurriedly mark answers that in many cases are not even good subjective responses to the questions. Then the researcher submits the results to a handy factor analysis program. Being disappointed in the results, he or she appeals to a statistician for help. They attempt to improve the results by trying different methods of extraction, different rotations, different values of m, and so on. But it is all to no avail. The scree plot looks more like the foothills than a steep cliff with gently sloping debris at the bottom. There is no clear value of m. They have to extract 10 or 12 factors to account for, say, 60% of the variance, and interpretation of this large number of factors is hopeless. If a few underlying dimensions exist, they are totally obscured by both systematic and random errors in marking the questionnaire. A factor analysis model simply does not fit such a data set, unless a large value of m is used, which gives useless results. It is not necessarily the "discreteness" of the data that causes the problem, but the "noisiness" of the data. The specified variables are not measured accurately. In some cases, discrete variables yield satisfactory results. On the other hand, continuous variables do not guarantee good results*".

Reality often lies between these two extreme examples! Even in the "lucky" cases where factors providing a satisfactory fit to the data are found, one should still be tentative in interpretation until the existence of the factors can be independently establish. If the same factors emerge in repeated sampling from the same population or a similar one, then one can have confidence that application of the model has uncovered some real underlying structure. Thus, it is good practice to repeat the experiment to check the stability of the factors. If the data set is large enough, it could be split in half and a factor analysis performed on each half. The two solutions could be compared with each other and with the solution for the complete set, in order to check if they could just be an artefact of the present sample and would not reappear in another sample from the same population. In our specific case, however, the dataset is too small to allow any splitting. It would be therefore impossible to cross-validate the extracted factors, the consequences will be analyzed in the following.

The factors emerging from factor analysis are affected by the samples from whom they are obtained. As described in /5/, there are two problems here, which lead to different formulation in practice. One argument indicates that sample should be homogeneous. For example, if we analyze a basin with scarce industrial development, it is likely that an Issue as "pollution by industrial discharges" would not load on "surface water pollution" to any great extent. This is because this sample is homogeneous for "scarce industrial development". However, if we were to carry out a similar study using the whole range of industrial development, industrial discharges would possibly load highly on a "water pollution factor". From this point of view, it might be concluded that heterogeneous samples should always be used. Homogeneous samples, by definition, lower variance and thus lower factor loadings. In exploratory factor analysis, therefore, generally it is best use heterogeneous samples and increase the variance.

However, there is another aspect to this argument which leads to a different conclusion. It can be argued that scores from different groups should not be added together. For example, if we studied two basins one with extreme and the other with low industrial development, to add them together and factor their scores would appear "nonsensical" since the "average industrial development" reflected by the factors would not reflect any member of the group. From this, the opposite conclusion might be concluded, i.e., that only homogeneous groups should be factored. This is however due to the fact that an unrepresentative sample has been used.

Samples must not only be representative but must be of sufficient size to produce reliable factors. In data with a clear factor structure, samples of around hundred members are considered to be of sufficient size to produce reliable factors (if factor analysis is carried out with smaller samples than the results should need replication with other samples) /5/. The general rule is obviously "the more subjects the better". However, a main role is played by the variable to subject ratio. There have been various claims made concerning the ratio of subjects to variables running from as large as 10:1 as the necessary minimum, down to 2:1 (again the rule is "the bigger the ratio the better"). Taking this general rule, our sample would be too poor, especially if the large number of variables is taken into account. However, it should be noted that /6/ claims the variable to subject ratio to be less important than the ratio of subject to factors (this last should be more than 20:1).

Due to the relative small sample of compiled Questionnaires (and the large number of analyzed Issues), it is necessary to analyze the dataset in its wholeness (i.e., factors would be extracted from the global, heterogeneous survey). The available sample size is far less than would be desired and with the heterogeneous survey it should be easier to identify clear factors (if present). One should however check the "robustness" of the (eventually) extracted factors with respect to the available data (but, in absence of a replication study, it will be hardly possible to claim their "generality"). One has to remember that our main aim is a cross-comparison among different Case Studies (and/or different Stakeholders), consequently, even the "hint" of a data specific "simpler structure" can be of interest.

Items selection and Principal Component Analysis

In order to start the analysis, a subset of the available variables has been selected. It has been decided to exclude the following Issues from the analysis:

- the first six Issues related to the "physical conditions", as they resemble some too general "attributes" of the case studies. We prefer to use them, as "markers", in a post analysis of the results and to support the interpretation of the eventually extract components/factors, see Section 0;
- the issue 3.5.2 "Deficiencies in preserving the minimum flow required for shipping/navigation purposes (low flow constraints)" as considered "ambiguous" being most of the case studies non navigable (see also Section 0).

The reduced dataset of 75 cases on 57 items (out of the original 64). was initially analyzed by Principal Components Analysis of the covariance matrix.

Many criteria have been suggested to decide how many principal components to retain (and select the number of factors to be extracted, in case of Factor Analysis), see, e.g. /5/. The main three are:

- Cattell's scree test criterion – the plot of the eigenvalues against their rank often provides a convenient visual method of separating the important components from the less-important components (looking for a natural break between the "large" eigenvalues and the "small" eigenvalues). It should be noted that, even in case of Factor Analysis, the scree test must be performed on principal components /5/;
- Kaiser's criterion – exclude those principal components with eigenvalues below the average.

- In case of Factor Analysis, use technique as “maximum likehood factor analysis” followed by a significance test (for sufficiently big samples).

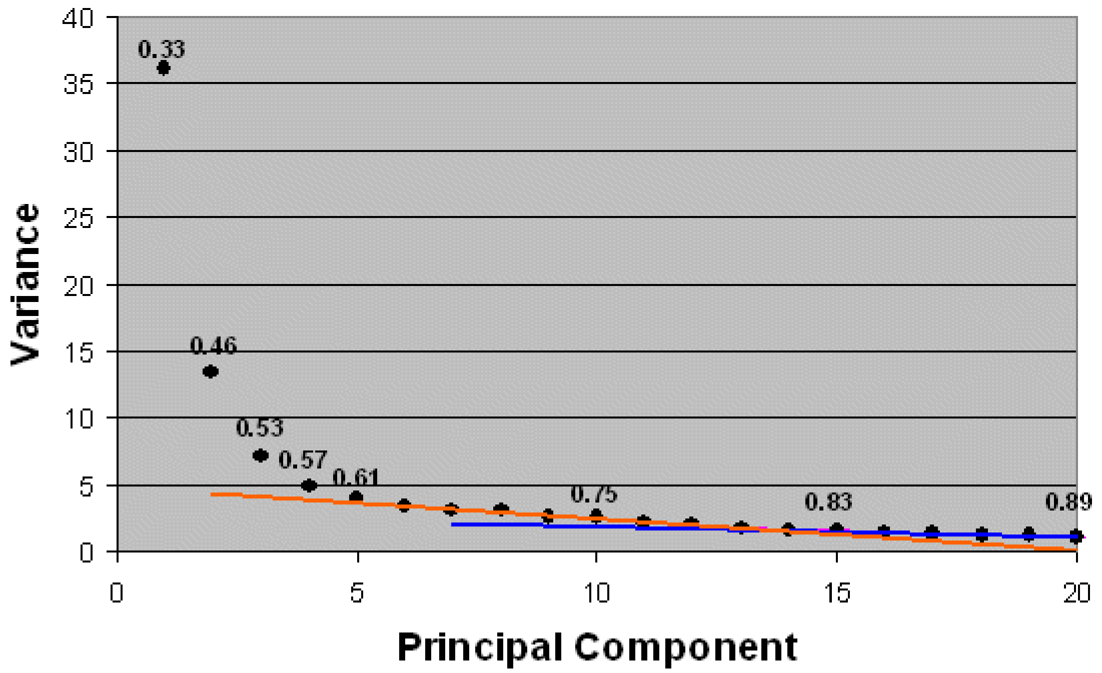

Figure 9 Scree plot of the Principal Component Analysis. The labels on top of representative points corresponds to the cumulative proportion of the explained variance

The scree plot, shown in Figure 9, supports a solution with 4-5 components. Alternative, a secondary break could be identified after the 10th component, a result compatible with the Kaiser criterion (that indicates 10-14 components).

We will use this result to guide to choice of the number of factors to be extracted (by factor analysis). After having tried different solutions, by extracting a different number of factors and checking their robustness and interpretability, two solutions will be presented. The first one is related to the extraction of only “essential” factors (4 factors), the second one will push the number of factors towards a higher number (11 factors).

The extraction of a too small number of factors (*underfactoring*), would tend to “telescope” factors together, and to produce second order factors (i.e., in case of an oblique rotation, the extracted factors tend to show relatively high correlations, that could be themselves factor analyzed, finding a second order structure). On the other side, in particular with reference to the present Questionnaire, we expect that the extraction of too many factors would *overfactoring*, allowing a subset of “bloated specific” factors to emerge (see Section 0)

Compact solution: 4 factors

By trying different numbers of factors, different extraction and rotation procedures, we came to the conclusion that the first few factor are sufficiently “robust” and reproducible independently of the implemented algorithms (including the technique used to impute “missing values”, see Section 0).

The solution obtained by extracting four (varimax rotated) orthogonal factors by principal factor estimate, treating the ordinal variables as continuous one is reported in Table 10. The behaviour of the factor loadings, for different classes of Items, is also shown graphically in Appendix (Figure 23).

The principal factor method of factor analysis is “identical” to that of principal components except that instead of unity in the diagonals (in case of analysis of the regression matrix) some other estimate of *communality* is inserted. This means that while the principal component method explain all variance in a matrix, the principal factor method does not. This, at least from a theoretical point of view, is an advantage, because it is unlikely that factors could explain all the variance in any given matrix, and, since all correlations contain errors, the full account of principal components must be contaminated by error.

The solution with four factors explains about 50% of the variation in the 57 variables of the original data. Even with the seven point scale, the variability of the scores assigned to the Questionnaire Items is limited, such that Pearson correlations are apart from ideal coefficients (a non-parametric analogous, as the rank-based Spearman's ρ, could be a better choice). Factors derived from item correlations, partly as a result of this problem of the correlation coefficients, tend to account for rather small proportions of variance in the matrix /5/.

Water Issue	fact1	fact2	fact3	fact4
INSTITUTIONAL FRAMEWORK - Institutional responsibilities	**-0.31**	0.52	0.28	0.29
INSTITUTIONAL FRAMEWORK - Active participation	**-0.42**	0.68	0.23	0.12
INSTITUTIONAL FRAMEWORK - Private sector participation	0.20	0.42	-0.17	-0.11
REGULATORY FRAMEWORK - Water quality standards, enforcement	0.12	0.52	0.29	0.11
REGULATORY FRAMEWORK - Water rights and conflict resolution	0.03	0.53	0.09	0.21
REGULATORY FRAMEWORK - Public information access rights	0.39	-0.15	0.17	0.11
WATER PRICING POLICIES - Too high, restrictive prices	-0.15	0.30	0.14	**-0.54**
WATER PRICING POLICIES - Too low, no controlling effect	0.23	0.14	0.15	0.43
WATER PRICING POLICIES - Deficiencies in the tariff structure	0.09	0.44	0.23	0.12
EDUCATION AND AWARENESS	-0.13	0.23	0.51	0.32
GENDER ISSUES - Equity in education and training	-0.14	0.23	0.50	0.18
GENDER ISSUES - Women in institutions	0.61	0.24	0.09	0.08
TECHNOLOGY AND INVESTMENTS - Obsolete technologies, maintenance	0.13	0.24	0.41	0.04
TECHNOLOGY AND INVESTMENTS - Techno-economic barriers	0.28	0.15	0.30	0.30
HOUSEHOLDS - Water quantity - Over-abstraction of surface water	0.28	0.03	0.18	0.25
HOUSEHOLDS - Water quantity - Over-pumping of groundwater	0.21	-0.01	0.19	0.44
HOUSEHOLDS - Water quality - Wastewater from households	0.64	0.06	-0.13	0.22
HOUSEHOLDS - Water quality - Uncontrolled solid waste disposal	0.50	-0.01	0.21	-0.03
HOUSEHOLDS - Water quality - Groundwater contamination (households)	0.67	0.13	-0.08	0.21
HOUSEHOLDS - Water quality - Groundwater contamination (waste dumps)	0.67	0.14	-0.17	0.03
HOUSEHOLDS - Water saving technologies	0.62	-0.13	0.15	0.19
HOUSEHOLDS - Impacts of population growth	0.88	-0.15	0.03	0.16
TOURISM - Water quantity - Surface water demand by tourism	0.87	0.11	0.19	0.02
TOURISM - Water quantity - Groundwater demand by tourism	0.86	0.11	0.20	0.03
TOURISM - Water quality - Surface water pollution by tourism	0.82	0.11	0.21	-0.01
TOURISM - Water quality - Groundwater pollution by tourism	0.83	0.14	0.20	-0.02
TOURISM - Water saving technologies	0.88	0.02	0.18	0.00
TOURISM - Increasing demands by sectoral growth	0.87	0.08	0.03	0.06
AGRICULTURE - Water quantity - Surface water demands	-0.03	0.40	0.19	0.66
AGRICULTURE - Water quantity - Groundwater demands	0.06	0.33	0.22	0.65
AGRICULTURE - Water quality - Surface water pollution by agriculture	0.12	0.51	0.03	0.51
AGRICULTURE - Water quality - Groundwater pollution by agriculture	0.20	0.54	0.06	0.50
AGRICULTURE - Water technologies (irrigation efficiency)	0.46	-0.04	0.19	0.32
AGRICULTURE - Agricultural expansion	0.59	0.25	0.00	0.33
INDUSTRY - Water quantity - Surface water use by industry	0.60	0.10	0.42	0.11
INDUSTRY - Water quantity - Groundwater extractions by industry	0.65	0.12	0.47	0.17
INDUSTRY - Water quality - Surface water pollution by industry	0.51	0.06	0.55	0.17
INDUSTRY - Water quality - Groundwater pollution by industry	0.60	0.08	0.58	0.22
INDUSTRY - Water saving technologies	0.58	-0.01	0.53	0.27
INDUSTRY - Impacts of industrial growth	0.54	-0.02	0.44	0.25
OTHER USES (environment, shipping, flood control) - Environmental water allocation	-0.08	0.31	0.05	0.11
OTHER USES (environment, shipping, flood control) - Flooding	0.24	-0.01	0.31	-0.09
QUANTITY - Conflicts from limited surface water	0.05	0.75	0.20	0.01
QUANTITY - Conflicts from limited groundwater	0.03	0.77	0.17	-0.02

QUANTITY - Alternative water resources	0.30	0.02	0.38	-0.17
QUANTITY - Dependency on water imports	0.50	0.11	0.09	-0.13
QUALITY - Surface water quality	0.34	0.31	0.27	0.02
QUALITY - Groundwater quality	0.43	0.47	0.29	-0.14
QUALITY - Limits to domestic use	0.24	0.60	0.31	0.14
QUALITY - Limits to recreational use	0.15	0.25	0.71	0.29
QUALITY - Limits to agricultural use	-0.06	0.46	0.67	0.13
QUALITY - Limits to industrial use	0.40	0.20	0.69	0.10
INFRASTRUCTURES - Abstraction, reservoirs, water harvesting	0.14	0.41	0.36	-0.11
INFRASTRUCTURES - Sanitation: sewers and treatment	0.65	0.43	0.04	-0.03
INFRASTRUCTURES - Distribution losses (canals, pipes)	0.33	0.58	-0.14	-0.08
INFRASTRUCTURES - Preservation of natural resources - Impact of infrastructures on biodiversity	0.43	0.52	-0.16	-0.17
INFRASTRUCTURES - Preservation of natural resources - Prevention of natural disasters	0.48	0.16	0.04	**-0.51**

Table 10 Water Issue Questionnaire: factor analysis – four factor (ordinal variables treated as continuous) - matrix of factor loadings. The following chromatic code is used: red - factor loadings whose absolute value is greater than 0.8; yellow - factor loadings whose absolute value is greater than 0.5, light blue - factor loadings whose absolute value is greater than 0.3. Negative factor loadings are highlighted in boldface

The more consistent (and complex) treatment of ordinal variables (estimation of the polychoric correlation and MINRES factoring method - see Section 0), brings to practically identical results (see Table 14, in Appendix, reporting the orthogonal varimax rotated factors). Indeed, this tends to confirm the statement of Bentler & Chou reported in Section 0, i.e., that given normally distributed ordinal variables, "*continuous methods can be used with little worry when a variable has four or more categories*" (/2/, p. 88).

The meaning of these factors has to be deduced from the factor loadings (see Table 10) with the auxiliary help of the correlation with other eventually available "markers" (as the "physical conditions" previously hold out from the factor analysis, see Section 0). The factor loadings are correlations of the original variables with the factors. It is usual to regard factor loadings as high if they are greater than 0.6 (the positive or negative sign is irrelevant) and moderately high if they are above 0.3 /5/. A factor loading of 0.3 indicates that 9% of the variance of the variable is accounted by the factor. It is common practise to take it as large enough to indicate the loading is salient. Other loadings (with absolute value smaller than 0.3) are generally ignored.

However, in reality, the usefulness of a loading (or a correlation) is determined by its statistical significance (i.e., the probability it could not have arisen just "by chance"). This depends, e.g., on the number of variables in the analysis and the number of extracted (and varimax rotated) factors. We have therefore tried an estimation of the probability that loadings could arise "by chance" through an "ad hoc" simulation. A "random sampling" from the original survey data was used in order to generate a battery of "artificial survey matrices" (75 rows – 57 columns). These random matrices were than submitted to factor analysis (4 varimax rotated factors). It was found that, in these "random surveys", the probability of obtaining, by chance, factor loadings higher (in absolute value) than 0.3 was about 13%, higher than 0.5 was 1.6% and only in 0.3% of the cases factor loadings higher than 0.8 would arise "casually".

Taking into account that in our analysis of the Survey data 228 factor loadings were extracted (57 variables x 4 factors) from the results of the previous simulations one could roughly expect about 30, 4 and 1 of them to be greater than, respectively, 0.3, 0.5, 0.8, just "by chance". In the original Survey data, these numbers were significantly higher, respectively: 60, 43 and 7, suggesting that, while factor loadings around 0.30 should still be taken with some care (i.e., they could have just found origin "by chance"), loadings higher than 0.4-0.5 are probably significant and could therefore be interpreted. However, correlations between items (especially if evaluated from ordinal variables) remain rather unreliable. The only way to overcome this uncertainty would be to use larger samples.

On the basis of factor loadings, we can propose the following interpretation of the four orthogonal factors. One has to notice that being orthogonal (varimax rotated), the four factors are uncorrelated (i.e., "independent"):

1st factor	**"Pressure" and "impact" on water demand and quality, mainly related to non-agricultural "driving forces"** (tourism, household, industry). Agriculture, the main source of stress in Mediterranean countries, loads only partially on this factor. Agriculture is possibly perceived as an "unavoidable background" present in every basin and tends therefore to emerge only in connection with other more "agriculture specific" Issues, as those included in the 2nd and 4th factors. The increasing demand for water resources, forecasted to be driven by the intensification of human activities (growths of "driving forces", agriculture and water import included), loads on this factor - showing a trend towards further increasing pressures. Further contributions to the pressure on water quantity and quality (both surface as well as groundwater) come from an unsatisfactory infrastructure (mainly in relation to the distribution network, sewer system, irrigation efficiency and deficiencies in the use of alternative water resources). The critical "status" of the basin is also reflected by the loading of "impact of the infrastructures on biodiversity and loss of habitat", on the factor. Criticalities in the regulatory and institutional framework tend not to be not put in direct relation with this factor, see, e.g., Figure 23 in Appendix. Relatively high loadings are found only for "social Issues", as "deficiencies in access to information" and one of the two "gender issues"; on the contrary, institutional responsibilities and lack of participation appears as anti-correlated to the 1st factor.
2nd factor	**Deficiencies in the regulatory and institutional "response"** (DPSIR Framework), **mainly in relation with Agriculture** This is the first factor where the impact of agriculture on water quantity and water quality loads directly (the other is the 4th). However, what the factor seems to suggest is, more than the impact of agriculture itself (that appears to be considered as "unavoidable", see discussion for the first factor), an unsatisfying Institutional "response" to the criticalities (classified under "Management" in Figure 23, in Appendix). This is reflected by overlap, conflict and fragmentation of competences between institutions; lack of participation; problems with private sector participation in the provision of water and sanitation; deficiencies in the management and enforcement of water quality standards and water rights. Such "unsatisfactory" circumstances seem to be related to a situation of conflict (arising from the limitation of surface and groundwater supply, also dictated by the too poor quality of the available resources that limits further their use). Deficiencies in tariff structure also loads on this factors (although the 4th factor seems to better isolate "unfair" water pricing policy), as well as deficiencies in the infrastructure (abstraction, distribution network, sanitation and sewer system).
3rd factor	**Techno-economical barriers and (industrial) impact on water quality** (limiting its further use due to "too low" quality) Although the loadings of the two explicit quality indicators (surface water and groundwater) are not very significant, this factor seems to reflect the limits to the water use dictated by too low quality (in particularly connected to the presence of industrial activities), obsolete technologies, maintenance and techno-economical barriers. Also one of the two the "gender Issues" as well as "lack of education/ awareness programmes and campaigns" happen

	to load on this factor.
4th factor	**"Subventioned" water price (agriculture and household)** This factor extract the "too low" water price, with respect to the implementation of a "full cost recovery" (and, consistently, is anti-correlated with the Issue "too high water price with respect to basic social needs or economic competitiveness of agricultural and industrial firms"). Among the "driving forces" (household, tourism, agriculture and industry), household and agriculture are found, as could be expected, correlated with the main deviations from the "full cost recovery". Among the four extracted factors, the 4th is the one where technological and infrastructural limits tend to play the minor role (see Figure 23 in Appendix)

Table 11 Proposed interpretation of the 4 factor solution

In the procedure for extracting the factors, no use is done of the fact that the available compiled Questionnaires refer to seven different (and independent) Case Studies. The set of compiled Questionnaires is treated as a single heterogeneous (see Section 0) input dataset, with no indications of which questionnaires belong to each one of the seven Case Studies. It is therefore interesting to analyze "post hoc" if the different Case Studies tend to present, with respect to the extracted Factors, significantly different behaviours. The results of such a kind of analysis are represented graphically in Figure 10, Figure 11, Figure 12 and Figure 13.

The 1st factor, shown in Figure 10, offers a rather clear discrimination among the different Case Studies. The Gediz (Turkey) and the Dhiarzos (Cyprus) basins tend to show systematically lower scorings. On the opposite, the most critical situation appears to be related with the Melian (Tunisia), the Wadi Zeimar/Alexander (Palestine/Israel) and the Zarqa (Jordan) rivers. One has to remember that this factor has been interpreted as mainly reflect the Pressure (prevalently related to non-agricultural "driving forces") on water quantity and quality (see Table 11).

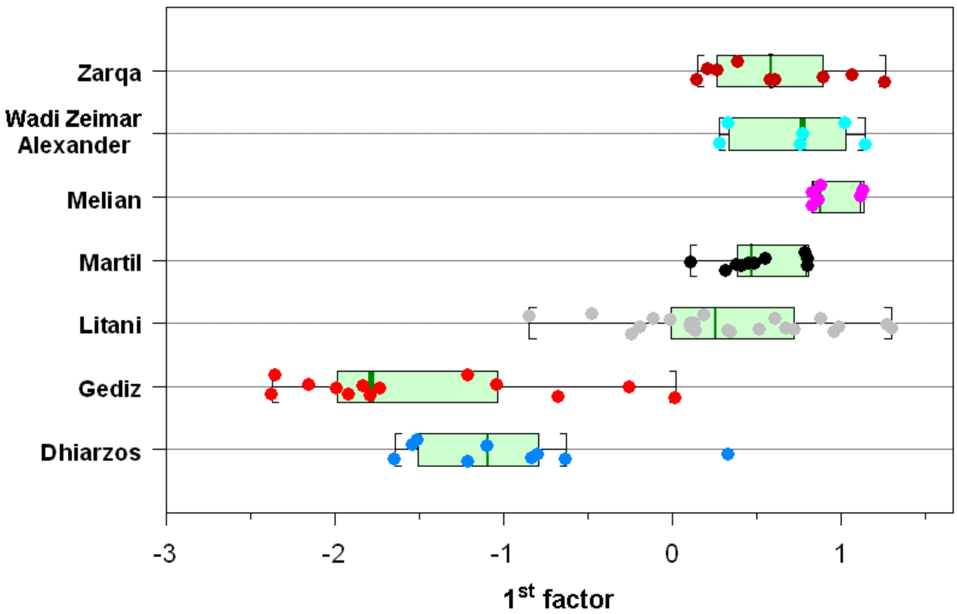

Figure 10 Factor scoring on the 1st factor, with the several respondents aggregated by Case Study. In the plot, the points are randomly "jittered" on the y-axis in order to obtain a clearer visualization.

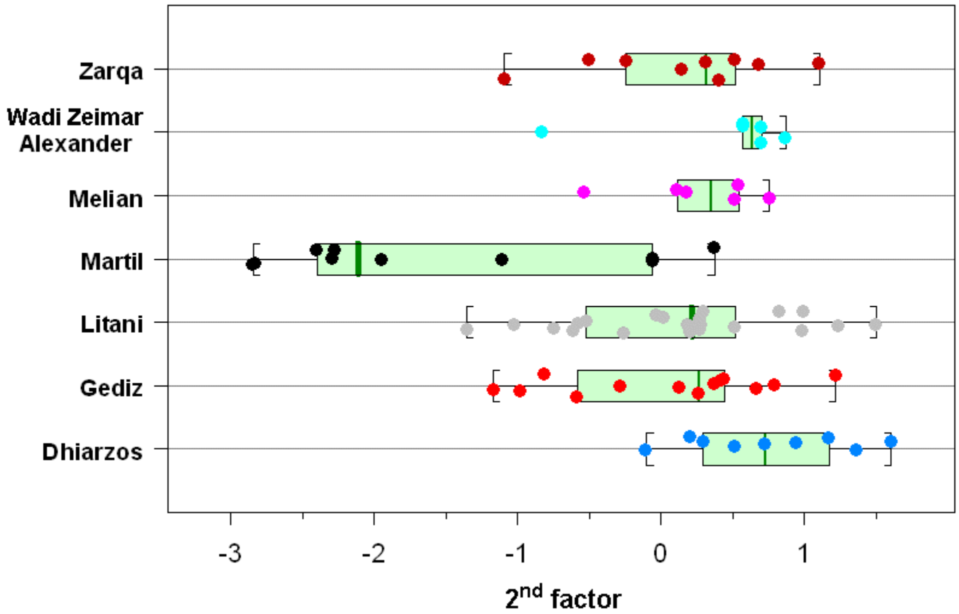

Figure 11 Same as Figure 10, for the 2nd factor

On the other side, the 2nd factor, interpreted as "Deficiencies in the regulatory and institutional response", mainly in relation to agriculture, tends to suggest the Wadi Zeimar/Alexander and the Dhiarzos river as the most critical cases. In the Martil basin, these topics load relatively low (however, with a considerable scattering, i.e., strong divergence among the opinion of the different respondents to the Questionnaire).

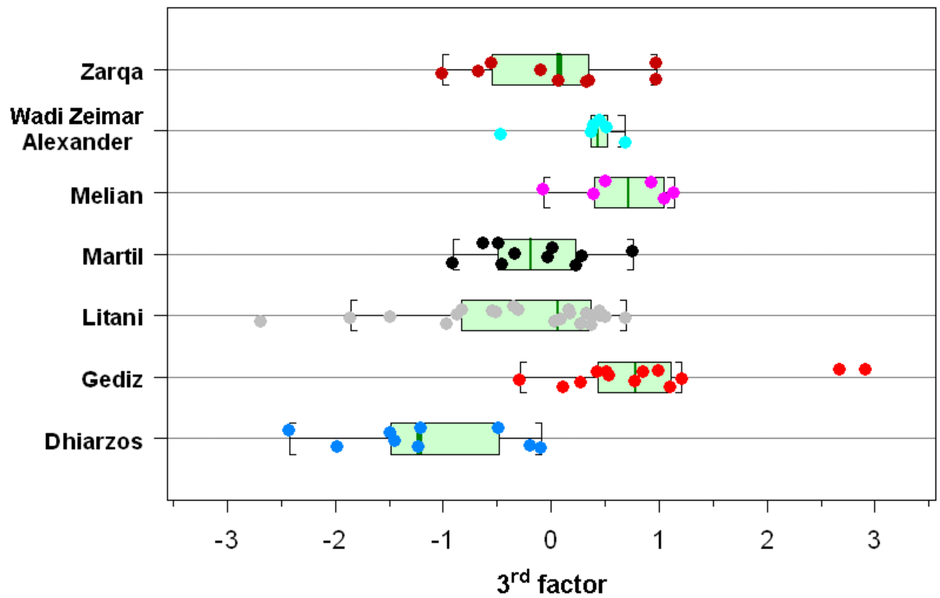

Figure 12 Same as Figure 10, for the 3rd factor

The analysis of the behaviour of the different Case Studies on the 3rd factor "Techno-economical barriers and (Industrial) impact on water quality" highlights two *outliers* for the Gediz Basin, i.e., two respondents of the Questionnaire gave an extremely high score to this Issue. They are identified as the "Menemen Left Bank Irrigation Association" and the "Menemen Right Bank Irrigation Association". In case the two responses represent the results of independent interviews (as it should be) and excluding that some error took place during the inputting and transfer of the data, this behaviour could reflect some extreme local conditions.

Gediz, Melian and Wadi Zeimar/Alexander show the highest scores, while the Dhiarzos river is again characterized by lower than average values.

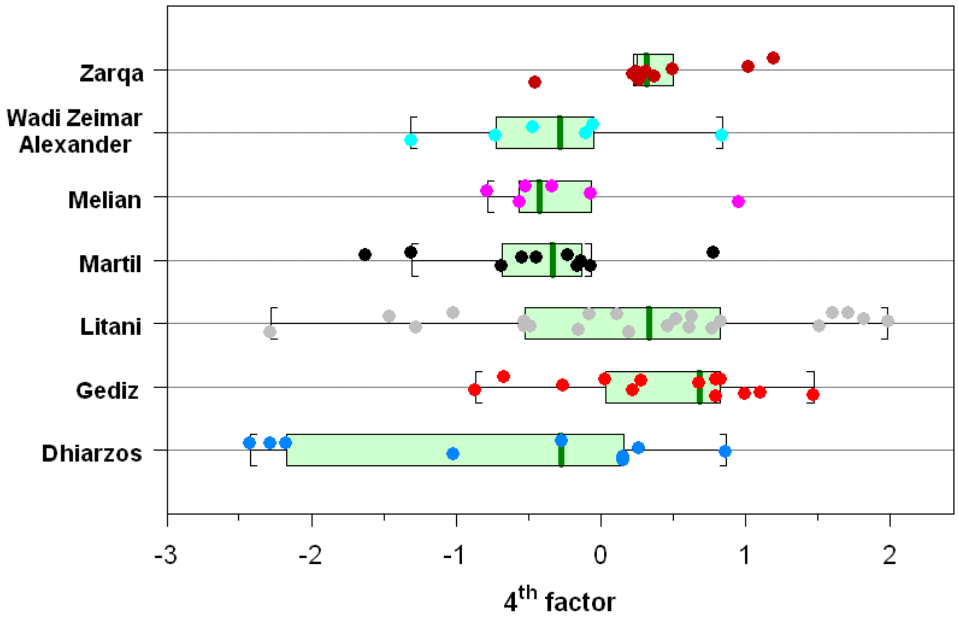

Figure 13 Same as Figure 10, for the 4th factor

The last factor, "Subventioned water price (agriculture and household)", shows a relatively high dispersion within the single Case Studies. E.g., it can be interesting to notice that in the Dhiarzos case, the lowest scorings reflect the opinion of the four Local Communities that took part to the Survey (the Local Community of Kedares, Pretori, Nikoklia, three points with extremely low values and the Local Community of Trachipedoula). The other Cyprus Stakeholders (for whom a compiled Questionnaire is available at the time of writing) show, on the other side, higher scores for this factor. Zarqa, Litani and Gediz tend, on average, to show the highest scorings.

The scorings on the first two factors are graphically shown in Figure 14. To highlight the distributional properties of the data (as well as the possible presence of "outliers"), the scatterplot is enhanced by representing the *bivariate boxplots* (i.e., the "two dimensional analogue" of the familiar boxplots for univariate data, see, e.g., /7/) associated to each Case Study. The *bivariate boxplots*, based on the calculation of "robust" measures, consist essentially of a pair of tilted concentric ellipses, one of which (full line) includes 50% of the data and the other (dotted line) which should delineate potential troublesome outliers.

It is evident from the Figure that, even if only the "global dataset" of compiled Questionnaires have been given as input to factor analysis (i.e., without specifying to which Case Study a single Questionnaire belongs to), the results on the first two factors can discriminate relatively well among most of the Case Studies under investigation. The "between-Case Study" variation tends generally to overcome the "within-Case Study" variation (related to the discrepancy in the point of view of different respondents) reflecting therefore some "specific characters" of the different Case Studies.

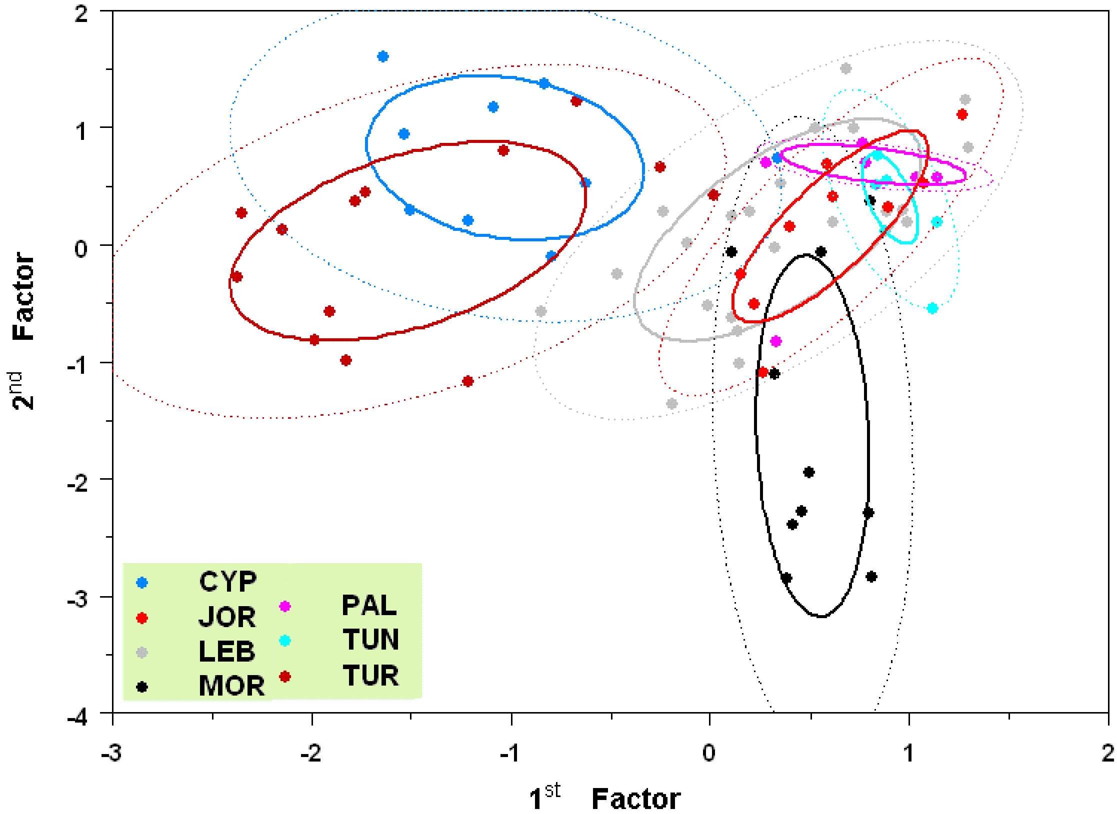

Figure 14 representation of the scores on the first two factors

To further help in the interpretation of the factors (or to further confirm the previously proposed one), the correlations between the 4 factors and the 6 Issues related to the "Physical Conditions" have been evaluated. We remember that these 6 Issues were left out from the factor analysis (see Section 0), as they considered to represent too general "attributes" of the Case Studies. As a measure of relationship, the rank-based Spearman's ρ has been used (similar conclusions are obtained if other nonparametric rank-based correlations as Gamma or Kendall's τ, or even the standard parametric Pearson sample correlation coefficient for continuous variables, are used).

From Table 12 one can notice that the highest correlation is between the 1st factors and the "Physical Condition" of "Watershed Degradation". "Floods" and "Coastal Interaction" loads significantly on the first factor as well. The second Factor (deficiencies in the regulatory and institutional "response") appears only to be correlated with "coastal interaction, while the third factor reflects the physical conditions of "Water Scarcity" and "Droughts". No physical condition appears to load significantly on the 4th "price related" extracted factor.

Physical Condition	fact1	fact2	fact3	fact4
WATER SCARCITY due to unfavourable hydrological and climatic conditions (e.g., precipitation/ evapotranspiration balance, seasonal distribution)	-0.20	0.20	**0.43**	0.04
FLOODS Recurrent floods (e.g., concomitant of heavy winter or spring rain storms)	**0.31**	-0.14	0.02	-0.08
DROUGHTS Recurrent droughts	-0.23	0.13	**0.28**	0.22
GROUNDWATER AVAILABILITY Limited groundwater resources (e.g., due to limited aquifer size	0.08	0.15	0.13	-0.17

and unfavourable access)				
WATERSHED DEGRADATION driven by environmental degradation processes resulting from climatic stress (e.g., desertification, salinisation of soils)	**0.71**	0.17	0.00	-0.13
COASTAL INTERACTION Coastal pollution due to run-off, salinity intrusion in coastal aquifers and estuaries	**0.44**	0.24	-0.02	-0.07

Table 12 correlations (rank-based Spearman's ρ) between the 4 Factors and the "Physical Conditions". Yellow and red background if statistical significant at the 0.01 level ($p<0.01$), light blue background if statistical significant at the 0.05 level.

A last analysis of the 4-factor solution, was dedicated to investigate if distinct classes of respondents (stakeholders) tended to score the extracted factors in a significantly different way. In order to detrend the data from the systematic differences observed in the different Case Studies (see Figure 10-Figure 13), the analysis was not done on the original scorings but on their deviations from the average value observed in the corresponding Case Study.

Four different aggregations of the Stakeholders (by "scope", by "size", by "category" and by "type", see Section0), were analyzed, in order to test if the (detrended) average scorings assigned by different classes of Stakeholders to each of the four factors differed in a significant way. The analysis was done by means of the method of analysis of variance (ANOVA) and of its alternative non-parametric equivalent: Kruskal-Wallis rank sum test.

The two methods agreed in selecting as "*highly significantly*" different (p-value < 0.01) the scoring on the 1st factor, when the responses were aggregated by "category", by "type" and by "scope". A further "*highly significantly*" difference was found for the 4th factor, aggregating the Stakeholders by "scope". No significantly different scoring (even at the p-value < 0.05 level) were instead observed for the 2nd and 3rd factors (for the 4 types of aggregation being tested).

Multiple comparisons identify the following pairwise combinations as sources of the discrepancies:

- 1st factor - aggregation by "category": "water use" vs. "environmental water use" and "water use" vs. "water production" ("water use" tends to assign lower scorings);
- 1st factor - aggregation by "type": "Local Authorities" vs. "Educational" and "Local Authorities" vs. "Governmental bodies" ("Local Authorities" tend to assign lower scorings);
- 1st factor - aggregation by "scope": "local" vs. "national" and "local" vs. "international" ("local" tends to assign lower scorings);
- 4th factor - aggregation by "scope": "local" vs. "national" ("local" tends to assign lower scorings).

As an example, the results on the 1st factor for the aggregation by "scope" (the results on the 4th factor are "relatively similar") are shown in Figure 15. By local Stakeholders, the "pressure and impact on water demand and quality (mainly related to non-agricultural driving forces)" seems to be perceived as "less critical" than by national ones.

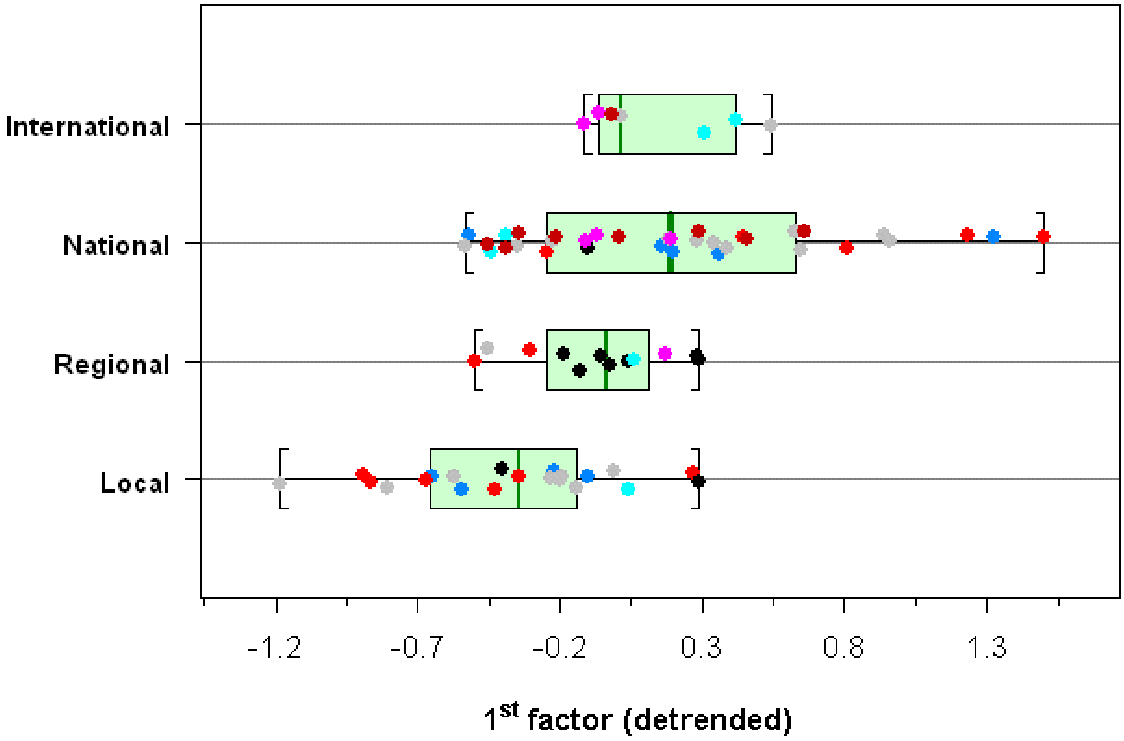

Figure 15 same as Figure 10 but discriminating for "scope" instead that for "Case Study". One can see how the "local Stakeholders" tend, on average, to assign lower scoring than the "national" ones.

Extended solution: 11 factors

The analysis of the scree plot in Figure 9, suggested the possibility of an extended solution related to a higher number of factors. We have investigated this possibility, also with the aim of testing the stability of the solution presented in the previous Section and to analyze how the factors tend to split when higher order solutions are allowed for.

The varimax rotated solution, when 11 factors are extracted, is reported in Appendix (Table 15). One can notice how the 1st extracted factors (i.e., the 1st column of Table 10 and the 1st column of Table 15) are practically "identical" in the two cases. This confirm the robustness of the relationship inherent to the available data, even when the number of extracted factor is let to increase. The same can be said, although to a lesser degree, for the 2nd and 3rd factors of the 4-factor solution that "re-emerge" in the 11-factor solution as, respectively, the 3rd and 2nd factors. The 4th factor can only be partly identified with the 7th factor in the 11-factor solution.

The other novel factors, in the 11th factor solutions, tend mainly to highlight:

- subclasses of correlated issues that could have a "physical meaning" (e.g., the 4th factor that isolates insufficient infrastructures and obsolete technology - particular critical in basin with conflicts for the limited available water resources);
- "clusters" of Issues whose high correlations are probably due to the fact that they are perceived, by most respondents, as re-formulation of the same concept (e.g., 6th factor that mainly collects all issues related to household water quality) - such kind of "clusters" are known as "bloated-specific factors" and will be discussed in Section 0;
- issues that presumably happen to be correlated just "by chance" (i.e., due to the relatively small sample of available data - even a set of random numbers would generate some "high" correlations, see discussion in Section 0). No "physical meaning" can be associated to them (e.g., 11th factor that highlights the connections between uncontrolled solid waste disposal, flood control and dependency on water imports). They are not expected to be reproduced by larger samples or by other, independently collected, datasets.

It is interesting that even increasing the number of extracted factors (i.e., from 4 to 11), the main factor still condenses the contributions from all the 3 “non agricultural” driving forces (i.e., household, tourism and industry appear together). Only allowing more freedom in selecting the position of factors in factor space, by means of an oblique rotation (i.e., releasing the constraint of orthogonality), it is possible to find solutions where the driving forces tend to load on different (but in this case correlated) factors.

Test construction and “bloated specific” factors

Another useful application of factor analysis can take place in the phase of the construction of tests /5/. Generally speaking, variance is made up of three components: common factor variance, specific factor variance and error variance. The last two are referred to as unique variance. Ideally the common factor variance of any variable should be as large as possible and unitary (accounted for by one factor alone). It follows from this factor analytic model of test variance that factor analysis is the ideal method for test construction. Thus by administering items and subjecting their intecorrelations to factor analysis it is possible to select items which load on only one factor. This ensures that the test is unifactorial.

Alternatively, the following steps can be implemented in order to design a reliable scale /8/:

- Step 1: Generating items. The first step is to write the items. This is essentially a creative process where the researcher makes up as many items as possible that seem to relate to the Issues to be investigated.
- Step 2: Choosing items of “optimum difficulty”. In the first draft of the questionnaire, are included “as many items as possible”. The questionnaire is then administered to an initial sample of typical respondents, and the results examined for each item. First, one would look at various characteristics of the items, for example, in order to identify “floor” or “ceiling” effects. If all respondents agree or disagree with an item, then it obviously does not help us discriminate between respondents, and thus, it is useless for the design of a reliable scale. In test construction, the proportion of respondents who agree or disagree with an item, or who answer a test item correctly, is often referred to as the item difficulty. In essence, we would look at the item means and standard deviations and eliminate those items that show extreme means, and zero or nearly zero variances.
- Step 3: Choosing internally consistent items. A reliable scale is made up of items that proportionately measure mostly true score. To do so, we would make a “*reliability analysis*”. The quantities of most interest are, e.g.: the correlation between the respective item and the total sum score (without the respective item), the squared multiple correlation between the respective item and all others, and the internal consistency of the scale (Cronbach's Alpha coefficient) if the respective item would be deleted. Clearly, few items can "stick out", in that they are not consistent with the rest of the scale. These items will be eliminated in Step 4.
- Step 4: Returning to Step 1. After deleting all items that are not consistent with the scale, we may not be left with enough items to make up an overall reliable scale (remember that, the fewer items, the less reliable the scale). In practice, one often goes through several rounds of generating items and eliminating items, until one arrives at a final set that makes up a reliable scale.

A reliable scale, designed following the 4 previous steps, will tend to load on a common factor. The higher the loading the better the test. However, if we write items which are (or are perceived as) essentially paraphrases of each other they will correlate highly and end up loading on a common factor. “Bloated specific” factors, a term used by Cattell (e.g., /9/), look like “normal” factors but are really only specific variance. “Bloated specific” factors can only be discriminated from common factors by the fact that they correlate with no other factors or external criteria /5/.

For example in the Water Issue Questionnaire several “too strongly” correlated Items were identified. This is probably due to the fact that the respondents failed to discriminate between the “subtle differences” implicit in the Item formulations and tended therefore to perceive the Items as “paraphrases of the same general Issue”. For example, all Issues related to “Tourism” appear extremely correlated (see Figure 16). Due to the variety of questions (covering water quantity, quality, technology and future projections, all referenced to Tourism), it is considered “highly improbable” for such high correlations to be “real” (this is, of course, a subjective opinion!). What it is supposed to have happened is that the respondents, due to the relatively limited knowledge of the “details” of the impact of Tourism (a secondary driving force), tend to give very similar ratings to all Tourism related Items (i.e., unimportant if tourism itself is considered un unimportant driving force, important if tourism is considered to be important). Furthermore, in the Questionnaire, all Tourism related Items were presented in a row (i.e., one after the other), facilitating a compilation using identical, or only slightly different, scoring. One has also to notice that the same effect doesn’t happen, e.g., in case of Agriculture, where the impacts are clearer and the respondents seem now able to discriminate among the different Agricultural related Issues (see Figure 17). A similar effect is also observed for all the couples of Items where the same Question was proposed twice, the first time referring to surface water the latter to groundwater (this can be observed even in Figure 17, were the demand of surface water and groundwater, as well as the pollution of surface water and groundwater, appear to be extremely correlated). All this surface water/groundwater doublets are “anomalously” correlated, suggesting the difficulty, for most respondents, to discriminate between impact on surface water and groundwater (i.e., the two water compartments tend to be perceived as mainly equivalent).

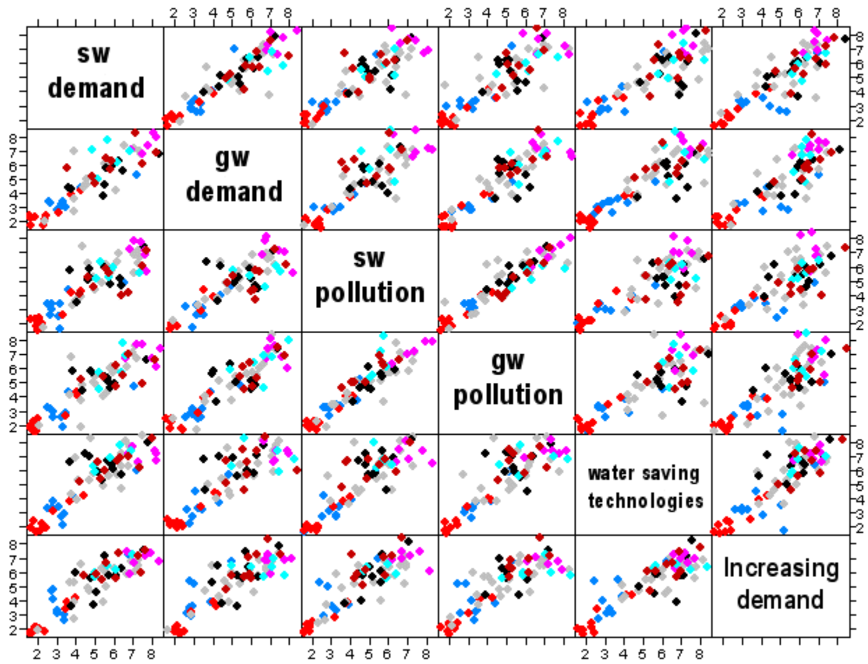

Figure 16 Scatter plot matrix showing the correlations between the ratings of tourism related Items (sw is an abbreviation for surface water, gw for groundwater). The points are “randomly jittered” in both the x- and y-directions to avoid overlapping, as all Items are rated on the 7-points ordinal scale (here represented as an integer scale from 2 ➔ Extremely unimportant to 8 ➔ Extremely important). Different colours are assigned to the 7 different OPTIMA Case Studies.

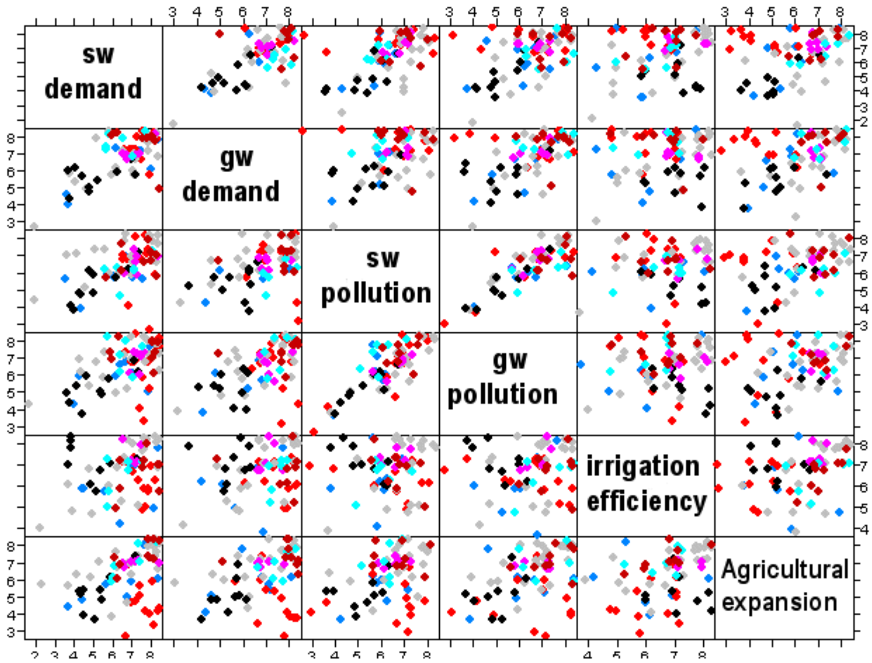

Figure 17 same as Figure 16, but now in relation to Agriculture related Items

Under this point of view, one can suppose the present form of the "Water Issue Questionnaire" to be somewhat "redundant". As a matter of facts, some Items tend to be perceived by the "average respondent" as "paraphrases of the same questions". It is this intrinsic redundancy, that can give origin to "bloated specific" factors, with little general value. The effect could be attenuated by eliminating few of the redundant Issues or (as a better choice) by creating "sum scales" (i.e., forming new variables made up of the sums or averages of the "clusters" of multiple "redundant" scores) before the data are submitted to the statistical analysis.

Complementary multivariate analysis

To complement the, previously reported, factor analysis other multivariate approaches have been investigated. The aim of these complementary applications is twofold:

- to check the reproducibility of the results obtained by factor analysis using alternative techniques, based on weaker assumptions (cluster analysis and multidimensional scaling);
- to approach different kind of questions as, focussing, on the identification of those variables (or linear combinations of variables) that show a substantially different scoring in the different OPTIMA case studies (Discriminant analysis).

Cluster analysis

In cluster analysis patterns in a data set are searched by grouping the (multivariate) observations into clusters. The goal is to find an optimal grouping for which the observations or objects within each cluster are similar, but the clusters are dissimilar to each other. The hope is therefore to find the "natural groupings" in the data. Cluster analysis differs fundamentally from classification analysis (as discriminant analysis, see 0). Aim of classification analysis, is to allocate the observations to a known number of predefined groups or populations. In cluster analysis, neither the number of groups nor the groups themselves are known in advance (or, if known, they are not used as input variables in the analysis).

To group the observations into clusters, many clustering techniques start by the similarities between all pairs of observations. In the most common application of cluster analysis, the similarities are based on some measure of distance (the most common is the usual Euclidean metric). It is, however, also possible to build a similarity starting by a correlation matrix (this is useful, e.g., with the objective of clustering the variables). Since most clustering methods use dissimilarities - such as distances, a conversion from the correlation matrix $R = (r_{i,j})$ to a dissimilarity matrix is needed. This can conveniently be done, starting from the correlation matrix, by replacing each $r_{i,j}$ by $1-| r_{i,j} |$ or $1- r_{i,j}^2$.

The implemented metric is discretionary. It is worth noticing that a cluster analysis of a dissimilarity matrix derived from Euclidean distances (i.e., the most common kind of analysis) and the cluster analysis of a dissimilarity matrix derived from the correlation matrix, present some conceptual differences. The analysis based on correlations tends to reflect the *intercorrelations* between the respondents (or the variables), whereas an Euclidean metric concentrate on the *distances* between them (see Figure 18 for an explanation of the consequences)..

In the case of the Water Issue Questionnaire, a cluster analysis of a dissimilarity matrix based on regression coefficients may offset systematic differences in judgement, concentrating more on the "profile" of the scores given to the different Issues than on the absolute value itself. A similar approach would be to employ in "Q-type factor analysis", however, being the number of respondents higher than the available Issues, this technique is limited by algebraically difficulties.

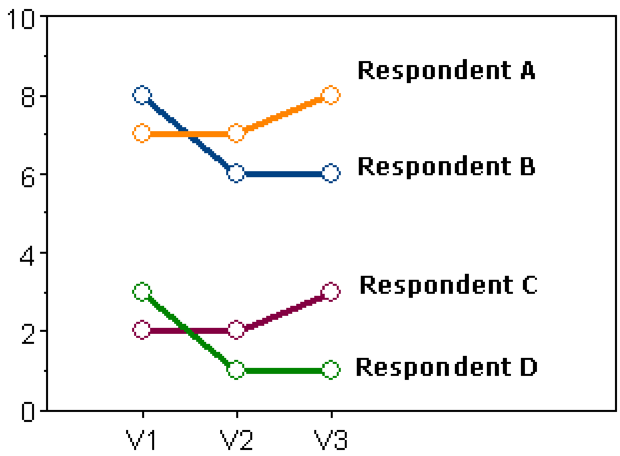

Figure 18 Illustrative example for cluster analysis of a dissimilarity matrix based on distance (would tend to form the following two clusters: 1st cluster ➔ Respondent A-Respondent B; 2nd cluster ➔ Respondent C-Respondent D) and on regression coefficients (1st cluster ➔ Respondent A-Respondent C and 2nd cluster ➔ Respondent B-Respondent D)

The application of cluster analysis for grouping variables and/or respondents tends to confirm the observations reported in the previous Sections. As an example, a 5 cluster solution is reported in Figure 19 and in Figure 20. The dissimilarity matrix is evaluated using all the 57 Items considered previously in Factor Analysis, and applying an Euclidean metric (the ordinal variables are treated as integer values). One can identify the 5 clusters as a "Dhiarzos-like", "Gediz-like", "Martil-like", "Melian-like" and "Zarqa-like". In this solution, Litani and Wadi Zeimar/Alexander River tend to "be scattered" on few of the previous clusters. Increasing the number of clusters, tends to further split the previous clusters in sub-clusters, without any main advantage in terms of classification power. The results, as well as the cluster interpretation in terms of underlying variables, tends to reflect the considerations already made in the frame of the Factor Analysis solution, in particular in terms of the first two extracted Factor (see Figure 14).

A parallel analysis using a dissimilarity matrix based on the correlation matrix, brings to rather similar results, the main difference being a “higher “ cross-population in the “Dhiarzos-like” cluster.

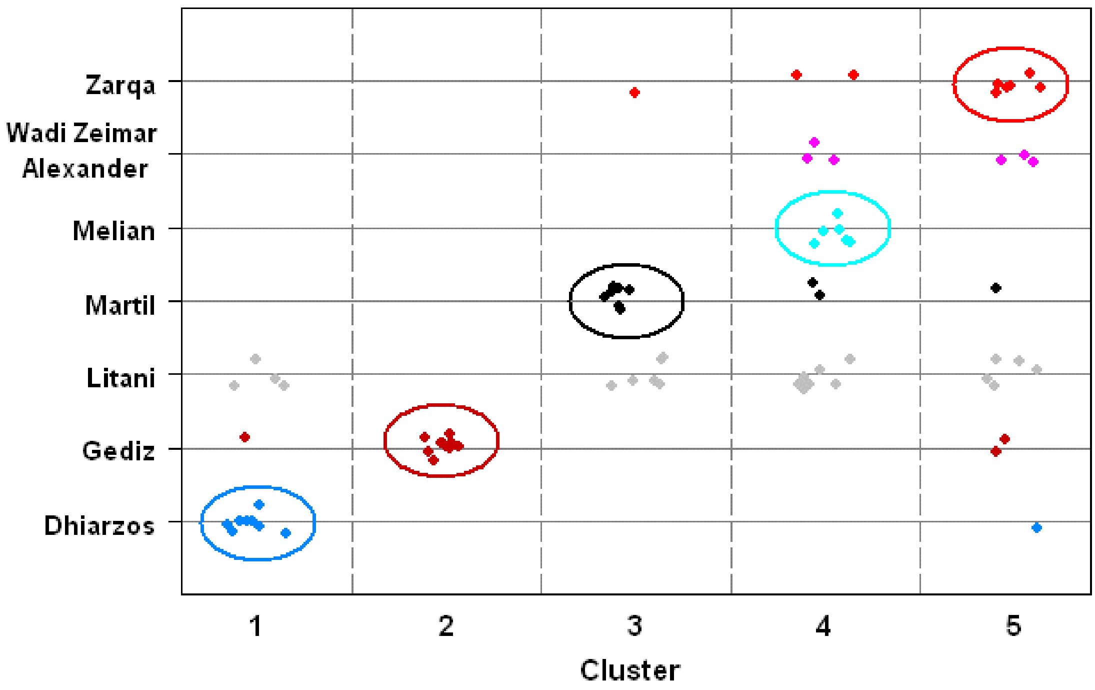

Figure 19 Result of a cluster analysis (*partitioning around medoids*) using Euclidean distance as the base for the dissimilarity matrix. The five cluster solutions is shown.

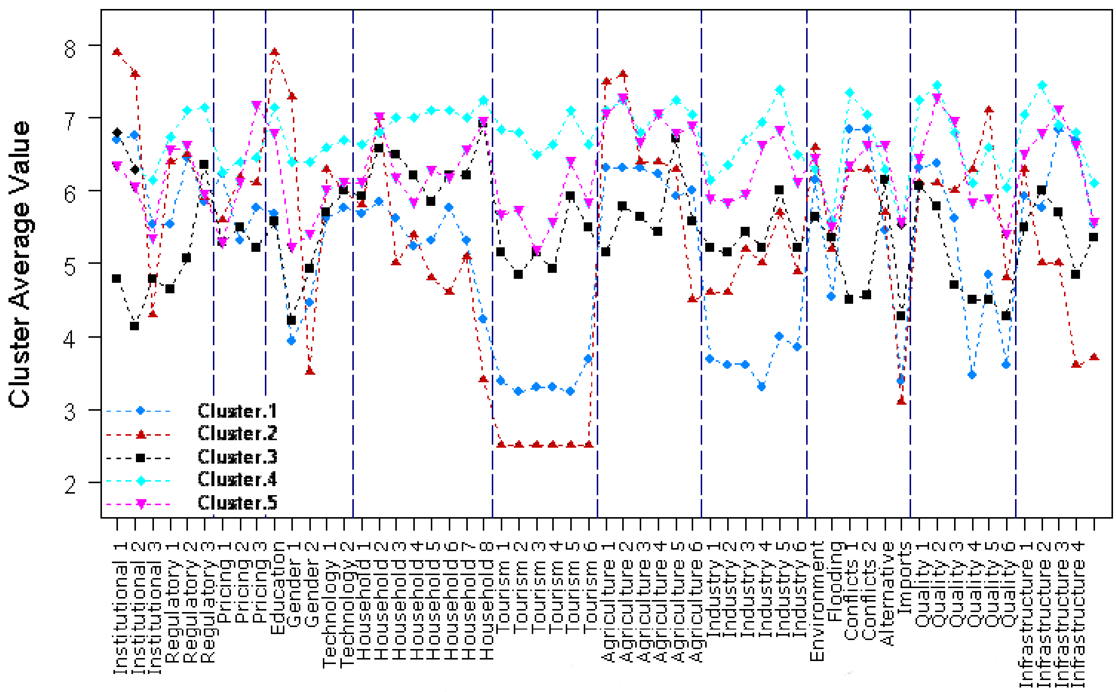

Figure 20 Average scores, evaluated for each Water Issue and for each of the clusters of Figure 19

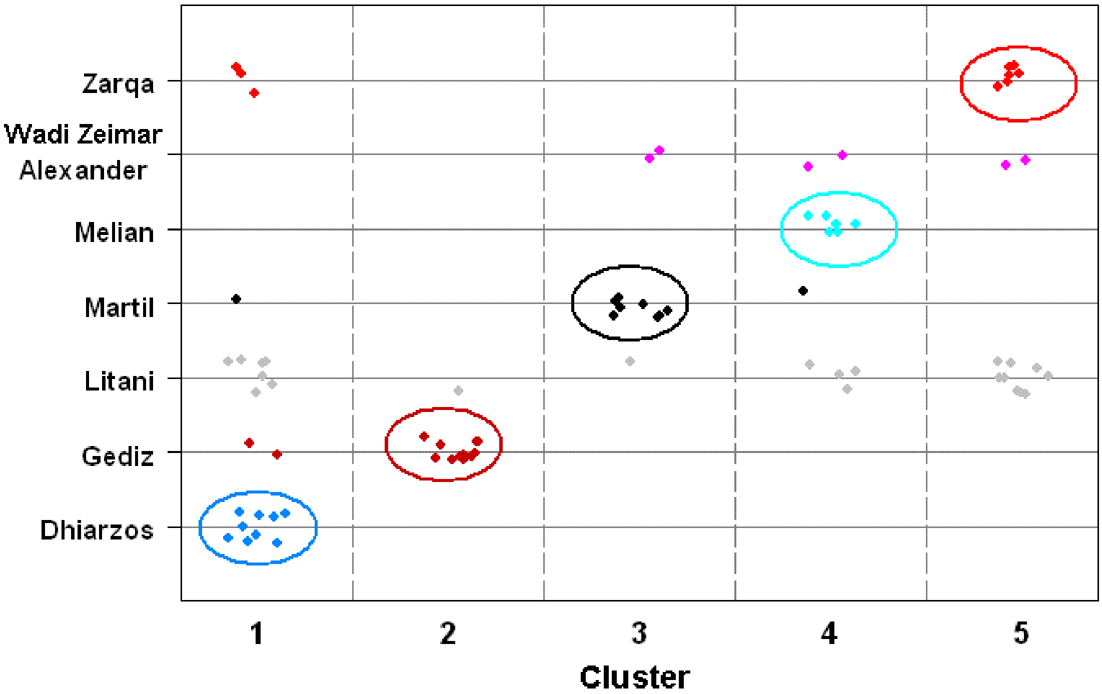

Figure 21 Same as Figure 18, but the correlation matrix (i.e., 1−| $r_{i,j}$|) is now used to build the dissimilarity matrix

Multidimensional scaling

Multidimensional scaling (MDS) can be considered to be a flexible alternative to factor analysis. In factor analysis, the similarities between objects (e.g., variables) are reflected by the correlation/covariance matrix. With multidimensional scaling, matrices of any kind of distances or similarities can be analyzed. The "beauty" of multidimensional scaling lies in its capability to analyze any kind of distance or similarity matrix.

Even though there are similarities in the type of research questions to which these two procedures can be applied, multidimensional scaling and factor analysis are fundamentally different methods. Standard factor analysis requires that the underlying data are distributed as multivariate normal, and that the relationships are linear. Multidimensional scaling imposes no such restrictions. As long as the rank-ordering of distances (or similarities) in the matrix is meaningful, multidimensional scaling can be used. In terms of resultant differences, factor analysis tends to extract more factors (dimensions) than multidimensional scaling; as a result, multidimensional scaling often yields more readily, interpretable solutions.

Multidimensional scaling is not so much an exact procedure, but rather a way to "rearrange" objects in an efficient manner. Starting, e.g., by a distance matrix, multidimensional scaling attempts to arrange "objects" in a space with a specified number of dimensions so as to reproduce the observed distances as good as possible. As a result, the distances can be "explained" in terms of underlying dimensions.

The analysis of the Questionnaire through multidimensional scaling, although its elasticity and its flexible definitions of distances, didn't bring to results of "easier interpretation" and tended to further support the factor analysis solution. The possibility of "re-arranging" the data in different dimensions, was investigated by the analysis of a "*scree plot*" (based on *D-star* "*raw stress values*" for consecutive numbers, up to 9, of dimensions – Euclidean distances of the ordinal scores treated as integers). The "*scree plot*" suggests, similar to factor analysis, that 4-5 dimensional solutions should bring to the best representation. Even a graphical illustration of the lowest dimensions tends to "resemble" the factor solutions. As no "innovative" information seems to be related to this straightforward application of multidimensional scaling, no further result will be reported.

So far, we have been concerned with the measure of "distances" among the different respondents. A complementary approach, can instead be based on the proximity between the different groups of respondents (e.g., taking into account the different case studies). There are two basic approaches to defining these inter-group proximities /10/. Firstly, the proximity between two groups might be defined by a suitable summary of the proximities between respondents from either group. Secondly, each group might be "condensed" into a single "representative observation" (e.g., the group mean value) and the inter-group proximity defined as the proximity between these "representative observations".

We have implemented this second approach. One obvious method for constructing inter-group dissimilarity measures would be to treat the variables as continuous and evaluate the average values scored, on each single Issue, by each single group (in the evaluation of the averages the approach used in Chapter 0 to build Table 8, could, alternatively, be used). Euclidean distance could then be evaluated from these mean values. More, appropriate, however, might be measures that incorporate, in one way or another, knowledge of within-group variation. One possibility is to use *Mahalanobis distance*, based on the *pooled* within-group covariance matrix /10/. When correlations between variables within groups are slight, the *Mahalanobis distance* will be similar to the Euclidean distance calculated on variables standardized by dividing by their within-group standard deviation. Thus, the *Mahalanobis distance* increases with increasing distance between the group centres and with decreasing within-group variation. By also employing within-group correlations the *Mahalanobis distance* takes account of the (possibly non-spherical) shape of the groups (see, e.g., Figure 14). The use of the *Mahalanobis distance* implies that willingness to assume that the covariance matrices are at least approximately the same in the groups under investigation (several alternatives have also been proposed for cases in which this assumption is inappropriate /10/).

To compare the different case studies, we have implemented the previous approach, by first estimating the average values and the pooled within-group covariance matrix[2] and successively the *Mahalanobis distances* between each pair of Case Studies. Classical multidimensional scaling was then applied to the obtained matrix of *Mahalanobis distances*. The analysis of the "*scree plot*" suggests a mainly one-dimensional solution (i.e., along the x-axis of the 2-D plot reported in Figure 22). The multidimensional scaling results, also in this case, tend to resemble those obtained in the framework of factor analysis, only the positioning associated to the Melian river is unexpected. One has however to notice that for the Melian (and the Wadi Zeimar/ Alexander) only 6 compiled Questionnaires are available at the time of writing. One can therefore expect, for these Case Studies, the results not to be "particularly robust", especially if based on evaluations of distributional properties as means and standard deviations).

[2] The *pooled* within-group covariance matrix is evaluated as $\mathbf{S}_{pl} = \Sigma\, [(n_i-1) \cdot \mathbf{S}_i] / \Sigma(n_i-1)$, where the sums extend over the groups, and n_i and S_i represent, respectively, the number of respondents and the correlation matrix associated with the i^{th} group

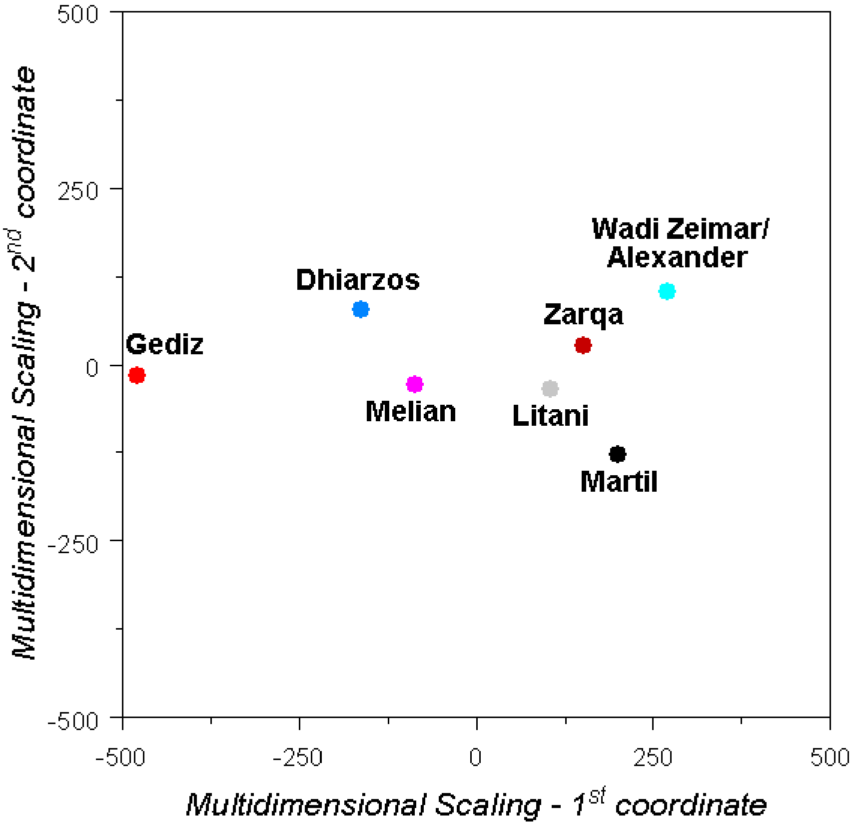

Figure 22 multidimensional scaling applied to the matrix of Mahalanobis distances. The solution, mainly one-dimensional, resembles that of Figure 14, apart from the positioning of the Melian river

Discriminant analysis

Discriminant analysis is used to determine which variables can be used to best discriminate among different groups. In our case it could be a useful technique to elucidate the differences between the groups, by finding linear combinations of variables that best separate the groups (e.g., the seven Case Studies) of multivariate observations.

In the OPTIMA case we will work with unequal sample sizes $n_1, n_2, \dots, n_k$. In applications, this situation is common and can be handled with no difficulty. However, ideally, the smallest n_i should exceed the number of variables (this is certainly not the case for the available data!). This is not required mathematically but will lead to more stable discriminant functions. The relative small sample size of data (especially when compared to the number of measured variables) strongly limits the aims of a Discriminant analysis, as, any eventual conclusion, will strictly be data specific without any generality (i.e., the variables that rank high in our sample may emerge as less important, or even insignificant in another "equivalent" sample). Any detailed specific analysis is therefore rather dubious.

However, we have applied Discriminant analysis with the following objectives:

- from our large number of dependent variables, we would like to discard those that are "redundant" (in the presence of the other variables) for separating the groups (i.e., in principle, we would like to keep those variables that might aid in discriminating among group membership but at the same time to delete any superfluous variables that do not contribute to this task);
- we would like to analyze the discriminating power of the four factor solution reported in Section 0.

The majority of selection schemes for classification analysis are based on stepwise discriminant analysis or a similar approach. Stepwise selection is a combination of the forward and backward approaches. Variables are added one at a time, and at each step, the variables are re-examined to see if any variable that entered earlier has become redundant in the presence of recently added variables. The procedure stops when the *largest partial F* among the variables available for entry fails to exceed a preset threshold value. The analysis (using unity as threshold for the *partial F*) splits the variables into two groups each one containing nearly half of the original 57 variables. We can rank the variables in terms of their relative contribution to group separation. The following 6 variables were found to be the most discriminating among the Case Studies: QUANTITY - Conflicts from limited groundwater, HOUSEHOLDS - Impacts of population growth, EDUCATION AND AWARENESS, TOURISM - Water quantity - Groundwater demand by tourism, HOUSEHOLDS - Water quantity - Over-pumping of groundwater and QUALITY - Limits to domestic use.

As already noticed, tourism emerges as an extremely discriminant Issue (for the OPTIMA Case Studies), but the six tourist related Issues are highly redundant (respondents tend to assign the same scoring to all of them, see Figure 16). Consequently, once two of the six Issues are included within the Discriminant variables, the other four can be ignored as they become highly redundant (i.e., they don't give any further information). Considerations of this kind can be useful for finding a subset of the original variables that separates the groups almost as well as the original set.

As a different approach Discriminant analysis was applied using as independent variables the four factors identified in Section 0, to check for their discriminating power. The four factor solution, can correctly discriminate between Dhiarzos (Cyprus), Gediz (Turkey), Martil (Morocco). On the other side, Litani (Lebanon), Melian (Tunisia), Wadi Zeimar/Alexander (Palestine/Israel) and Zarqa (Jordan) tend to be "too similar" for an "exact" discrimination in the 4 factor space (as could be expected from Figure 14).

Conclusions

In the present document, the responses to the "Water Issue Questionnaires" by selected Stakeholders of the seven OPTIMA Case Studies, have been analyzed. The available dataset consisted of the scorings assigned by 75 Stakeholders to the 64 Issues of the Questionnaire. The scorings were assigned on a symmetric 7-point ordinal scale – consisting of ordered categories ranging from "extremely unimportant" to "extremely important". Consequently, the available data were not continuous. Specific techniques, developed for such kind of data (see Section 0), have been applied. However, although some authors warn against applying the common multivariate techniques designed for continuous data, it has been found that, as often supported in literature, many common multivariate techniques for continuous variables give reliable results even when applied to the Survey ordinal data (see, e.g., Section 0).

The major part of the work was dedicated to the application of exploratory factor analysis with the aim of exploring the field and discovering eventual constructs or dimensions. Explorative factor analysis is ideal where data are complex and it is uncertain what the most important variables in the field are. One of the most attractive aspects of factor analysis as a statistical method is that it can reveal constructs which were previously unknown.

Two "factor analysis" solutions were derived and presented. The first one was related to the extraction of only "essential" and "sufficiently robust" factors (4 factors – Section 0), while in the second, the number of extracted factors was pushed towards higher values (11 factors – Section 0).

While the 4 factor solution can be interpreted and is rather "robust" and "reproducible" (even by other multivariate techniques based on weaker assumptions - as multidimensional scaling), the 11 factor solution seems to loose its "generality", mainly allowing a subset of "bloated specific" factors to emerge (*overfactoring*, see Section 0).

The four factor solution has been interpreted in terms of the following factors:

1st factor: "Pressure" and "impact" on water demand and quality, mainly related to non-agricultural "driving forces" (tourism, household, industry).

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2nd factor:	Deficiencies in the regulatory and institutional "response" (DPSIR Framework), mainly in relation with Agriculture
3rd factor:	Techno-economical barriers and (industrial) impact on water quality
4th factor:	"Subventioned" water price (agriculture and household)

The seven OPTIMA Case Studies were shown to present different scorings on the 4 factors, basically reflecting the different criticalities and priorities of the investigated watersheds. Also a tendency to assign different scorings, can be observed for few classes of Stakeholders (e.g., local Stakeholders can show a tendency to be "less critical" than the ones operating on the national scale, see Figure 15).

The present form of the "Water Issue Questionnaire" is probably somewhat "redundant", as several Items seem to be perceived as "paraphrases of the same questions" by the "average respondent". This intrinsic redundancy, can give origin, as discussed in the frame of the 11 factor solutions, to factors with little general value ("bloated specific" factors). The effect could be attenuated by eliminating few of the redundant Issues or (as a better choice) by creating "sum scales" (i.e., forming new variables made up of the sums or averages of the "clusters" of multiple "redundant" scores) before the data are submitted to the statistical analysis.

The relative small sample size of the available data (especially if compared to the number of variables) strongly limits the applicability of several multivariate techniques (as discriminant analysis and factor analysis itself). Furthermore, as a consequence of the small sample size, the generality of the obtained results cannot be "guaranteed" (i.e., they could partially be "data specific artefacts" and not emerge in other "equivalent samples"). A validation of the results on an independent dataset (or a further increase in the number of compiled questionnaires) is therefore desirable.

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Appendix

Code	Class	Water Issue	"don't know"	"missing values"	Total "not quantified"
1.1	PHYSICAL CONDITIONS	WATER SCARCITY	0 (0%)	0 (0%)	0 (0%)
1.2	PHYSICAL CONDITIONS	FLOODS	0 (0%)	0 (0%)	0 (0%)
1.3	PHYSICAL CONDITIONS	DROUGHTS	0 (0%)	0 (0%)	0 (0%)
1.4	PHYSICAL CONDITIONS	GROUNDWATER QUANTITY, QUALITY	0 (0%)	1 (1.3%)	1 (1.3%)
1.5	PHYSICAL CONDITIONS	WATERSHED DEGRADATION	0 (0%)	3 (4.0%)	3 (4.0%)
1.6	PHYSICAL CONDITIONS	COASTAL INTERACTION	8 (10.7%)	6 (8.0%)	14 (18.7%)
2.1.1	WATER MANAGEMENT	INSTITUTIONAL FRAMEWORK - Institutional responsibilities	0 (0%)	3 (4.0%)	3 (4.0%)
2.1.2	WATER MANAGEMENT	INSTITUTIONAL FRAMEWORK - Active participation	0 (0%)	3 (4.0%)	3 (4.0%)
2.1.3	WATER MANAGEMENT	INSTITUTIONAL FRAMEWORK - Private sector participation	2 (2.7%)	7 (9.3%)	9 (12.0%)
2.2.1	WATER MANAGEMENT	REGULATORY FRAMEWORK - Water quality standards, enforcement	4 (5.3%)	2 (2.7%)	6 (8.0%)
2.2.2	WATER MANAGEMENT	REGULATORY FRAMEWORK - Water rights and conflict resolution	4 (5.3%)	3 (4.0%)	7 (9.3%)
2.2.3	WATER MANAGEMENT	REGULATORY FRAMEWORK - Public information access rights	6 (8.0%)	6 (8.0%)	12 (16.0%)
2.3.1	WATER MANAGEMENT	WATER PRICING POLICIES - Too high, restrictive prices	2 (2.7%)	0 (0%)	2 (2.7%)
2.3.2	WATER MANAGEMENT	WATER PRICING POLICIES - Too low, no controlling effect	2 (2.7%)	13 (17.3%)	15 (20.0%)
2.3.3	WATER MANAGEMENT	WATER PRICING POLICIES - Deficiencies in the tariff structure	2 (2.7%)	15 (20.0%)	17 (22.7%)
2.4	WATER MANAGEMENT	EDUCATION AND AWARENESS	0 (0%)	1 (1.3%)	1 (1.3%)
2.5.1	WATER MANAGEMENT	GENDER ISSUES - Equity in education and training	0 (0%)	6 (8.0%)	6 (8.0%)
2.5.2	WATER MANAGEMENT	GENDER ISSUES - Women in institutions	0 (0%)	4 (5.3%)	4 (5.3%)
2.6.1	WATER MANAGEMENT	TECHNOLOGY AND INVESTMENTS - Obsolete technologies, maintenance	0 (0%)	0 (0%)	0 (0%)
2.6.2	WATER MANAGEMENT	TECHNOLOGY AND INVESTMENTS - Techno-economic barriers	0 (0%)	5 (6.7%)	5 (6.7%)
3.1.1.3	WATER DEMAND	HOUSEHOLDS - Water quantity - Over-abstraction of surface water	0 (0%)	1 (1.3%)	1 (1.3%)
3.1.1.3	WATER DEMAND	HOUSEHOLDS - Water quantity - Over-pumping of groundwater	0 (0%)	2 (2.7%)	2 (2.7%)
3.1.2.1	WATER DEMAND	HOUSEHOLDS - Water quality - Wastewater from households	1 (1.3%)	1 (1.3%)	2 (2.7%)
3.1.2.2	WATER DEMAND	HOUSEHOLDS - Water quality - Uncontrolled solid waste disposal	3 (4.0%)	3 (4.0%)	6 (8.0%)
3.1.2.3	WATER DEMAND	HOUSEHOLDS - Water quality - Groundwater contamination (households)	1 (1.3%)	1 (1.3%)	2 (2.7%)
3.1.2.4	WATER DEMAND	HOUSEHOLDS - Water quality - Groundwater contamination (waste dumps)	0 (0%)	3 (4.0%)	3 (4.0%)
3.1.3	WATER DEMAND	HOUSEHOLDS - Water saving technologies	1 (1.3%)	3 (4.0%)	4 (5.3%)
3.1.4	WATER DEMAND	HOUSEHOLDS - Impacts of population growth	1 (1.3%)	3 (4.0%)	4 (5.3%)
3.2.1.1	WATER DEMAND	TOURISM - Water quantity - Surface water demand by tourism	3 (4.0%)	3 (4.0%)	6 (8.0%)
3.2.1.2	WATER DEMAND	TOURISM - Water quantity - Groundwater demand by tourism	3 (4.0%)	2 (2.7%)	5 (6.7%)
3.2.2.1	WATER DEMAND	TOURISM - Water quality - Surface water pollution by tourism	3 (4.0%)	1 (1.3%)	4 (5.3%)
3.2.2.2	WATER DEMAND	TOURISM - Water quality - Groundwater pollution by tourism	3 (4.0%)	1 (1.3%)	4 (5.3%)
3.2.3	WATER DEMAND	TOURISM - Water saving technologies	3 (4.0%)	3 (4.0%)	6 (8.0%)
3.2.4	WATER DEMAND	TOURISM - Increasing demands by sectoral growth	3 (4.0%)	0 (0%)	3 (4.0%)
3.3.1.1	WATER DEMAND	AGRICULTURE - Water quantity - Surface water demands	0 (0%)	1 (1.3%)	1 (1.3%)

3.3.1.2	WATER DEMAND	AGRICULTURE - Water quantity - Groundwater demands	0 (0%)	3 (4.0%)	3 (4.0%)
3.3.2.1	WATER DEMAND	AGRICULTURE - Water quality - Surface water pollution by agriculture	0 (0%)	2 (2.7%)	2 (2.7%)
3.3.2.2	WATER DEMAND	AGRICULTURE - Water quality - Groundwater pollution by agriculture	0 (0%)	0 (0%)	0 (0%)
3.3.3	WATER DEMAND	AGRICULTURE - Water technologies (irrigation efficiency)	1 (1.3%)	1 (1.3%)	2 (2.7%)
3.3.4	WATER DEMAND	AGRICULTURE - Agricultural expansion	0 (0%)	4 (5.3%)	4 (5.3%)
3.4.1.1	WATER DEMAND	INDUSTRY - Water quantity - Surface water use by industry	3 (4.0%)	3 (4.0%)	6 (8.0%)
3.4.1.2	WATER DEMAND	INDUSTRY - Water quantity - Groundwater extractions by industry	3 (4.0%)	2 (2.7%)	5 (6.7%)
3.4.2.1	WATER DEMAND	INDUSTRY - Water quality - Surface water pollution by industry	3 (4.0%)	3 (4.0%)	6 (8.0%)
3.4.2.2	WATER DEMAND	INDUSTRY - Water quality - Groundwater pollution by industry	3 (4.0%)	1 (1.3%)	4 (5.3%)
3.4.3	WATER DEMAND	INDUSTRY - Water saving technologies	3 (4.0%)	3 (4.0%)	6 (8.0%)
3.4.4	WATER DEMAND	INDUSTRY - Impacts of industrial growth	3 (4.0%)	5 (6.7%)	8 (10.7%)
3.5.1	WATER DEMAND	OTHER USES (environment, shipping, flood control) - Environmental water allocation	0 (0%)	6 (8.0%)	6 (8.0%)
3.5.2	WATER DEMAND	OTHER USES (environment, shipping, flood control) - Shipping	6 (8.0%)	10 (13.3%)	16 (21.3%)
3.5.3	WATER DEMAND	OTHER USES (environment, shipping, flood control) - Flooding	0 (0%)	7 (9.3%)	7 (9.3%)
4.1.1	WATER SUPPLY	QUANTITY - Conflicts from limited surface water	0 (0%)	3 (4.0%)	3 (4.0%)
4.1.2	WATER SUPPLY	QUANTITY - Conflicts from limited groundwater	1 (1.3%)	2 (2.7%)	3 (4.0%)
4.1.3	WATER SUPPLY	QUANTITY - Alternative water resources	1 (1.3%)	3 (4.0%)	4 (5.3%)
4.1.4	WATER SUPPLY	QUANTITY - Dependency on water imports	1 (1.3%)	12 (16.0%)	13 (17.3%)
4.2.1	WATER SUPPLY	QUALITY - Surface water quality	0 (0%)	2 (2.7%)	2 (2.7%)
4.2.2	WATER SUPPLY	QUALITY - Groundwater quality	0 (0%)	0 (0%)	0 (0%)
4.2.3	WATER SUPPLY	QUALITY - Limits to domestic use	0 (0%)	2 (2.7%)	2 (2.7%)
4.2.4	WATER SUPPLY	QUALITY - Limits to recreational use	0 (0%)	3 (4.0%)	3 (4.0%)
4.2.5	WATER SUPPLY	QUALITY - Limits to agricultural use	0 (0%)	1 (1.3%)	1 (1.3%)
4.2.6	WATER SUPPLY	QUALITY - Limits to industrial use	0 (0%)	3 (4.0%)	3 (4.0%)
4.3.1	WATER SUPPLY	INFRASTRUCTURES - Abstraction, reservoirs, water harvesting	1 (1.3%)	2 (2.7%)	3 (4.0%)
4.3.2	WATER SUPPLY	INFRASTRUCTURES - Sanitation: sewers and treatment	1 (1.3%)	0 (0%)	1 (1.3%)
4.3.3	WATER SUPPLY	INFRASTRUCTURES - Distribution losses (canals, pipes)	0 (0%)	2 (2.7%)	2 (2.7%)
4.3.4.1	WATER SUPPLY	INFRASTRUCTURES - Preservation of natural resources - Impact of infrastructures on biodiversity	0 (0%)	2 (2.7%)	2 (2.7%)
4.3.4.2	WATER SUPPLY	INFRASTRUCTURES - Preservation of natural resources - Prevention of natural disasters	0 (0%)	1 (1.3%)	1 (1.3%)

Table 13 Number and percentage of "missing values" met in the analysis of the 75 available questionnaires. The first two numerical columns (grey background) correspond, respectively, to answer classified as "don't know" and to "empty entries" (no value at all is associated to the item). The last column (light blue background) is the sum of the two previous ones and represents the number (and percentage) of answer not classified on the symmetric (ranging from "extremely unimportant" to "extremely important") 7-point ordinal scale

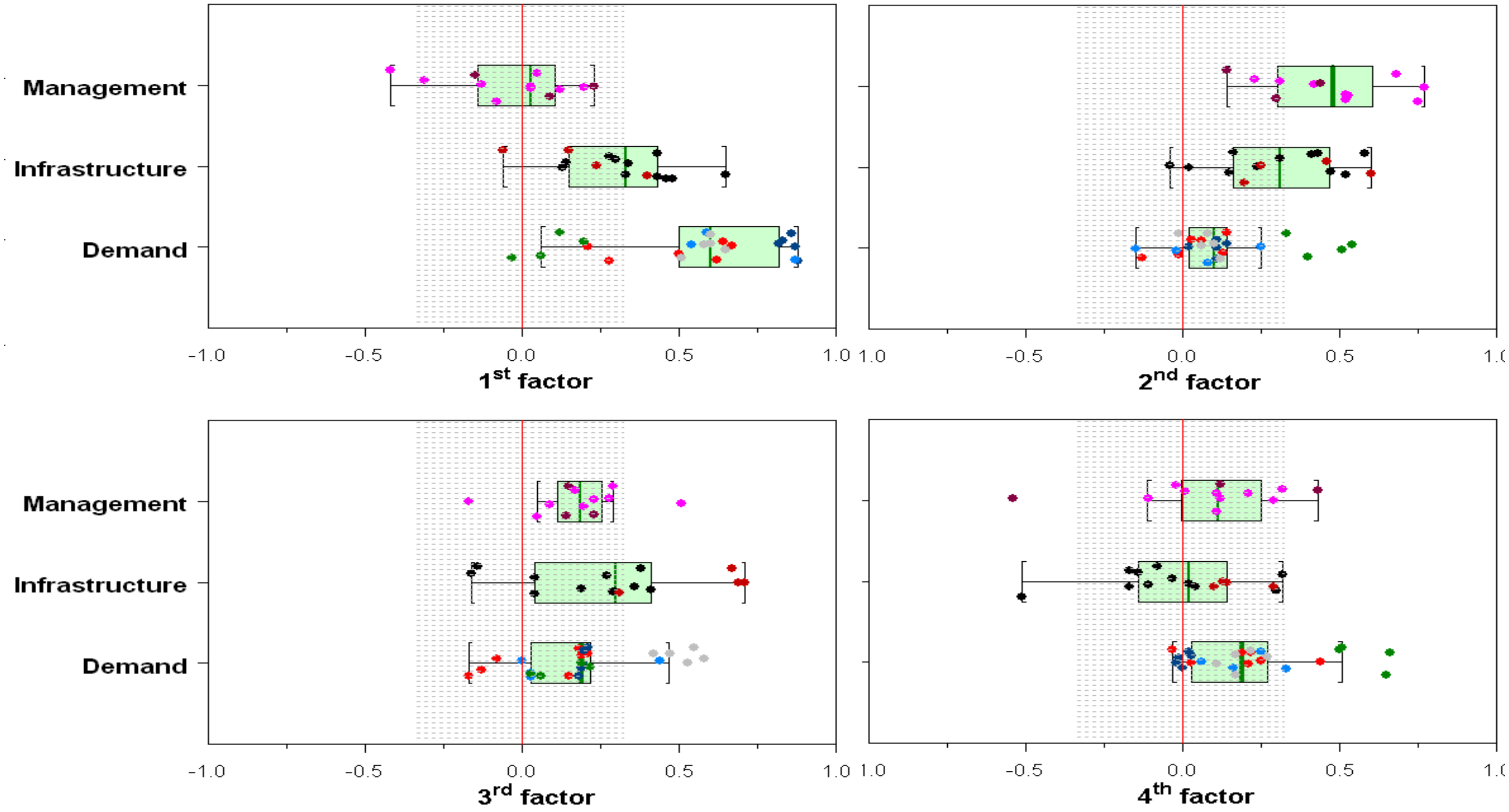

Figure 23 Loadings of the Questionnaire variables on the 4 factors. The variables have been (subjectively) classified as related to: “management”, “infrastructure” or “water demand” (neglecting the following 5 transversal variables: “Public information access right”, the two for “Gender Issue”, “Other Use: flooding” and “Dependence on water imports”). In the “management” group, questions related to “water pricing” are highlighted in brown. In the “infrastructure” group, points related to “limits in the use of water due to low quality” are in lighter brown. In the “demand” group the following code has been used: agriculture – green, households – red, industry – grey, tourism – blue; expected impacts due to sector growths – light blue. The plotted values are those reported in Table 10.

Water Issue	1st factor	2nd factor	3rd factor	4th factor
INSTITUTIONAL FRAMEWORK - Institutional responsibilities	-0.37	0.54	0.38	0.20
INSTITUTIONAL FRAMEWORK - Active participation	**-0.47**	0.58	0.29	0.24
INSTITUTIONAL FRAMEWORK - Private sector participation	0.22	0.47	-0.15	-0.07
REGULATORY FRAMEWORK - Water quality standards, enforcement	0.14	0.48	0.26	0.16
REGULATORY FRAMEWORK - Water rights and conflict resolution	0.03	0.54	0.15	0.16
REGULATORY FRAMEWORK - Public information access rights	0.46	-0.18	0.17	0.10
WATER PRICING POLICIES - Too high, restrictive prices	-0.10	0.30	0.14	**-0.60**
WATER PRICING POLICIES - Too low, no controlling effect	0.20	0.13	0.16	0.45
WATER PRICING POLICIES - Deficiencies in the tariff structure	0.10	0.43	0.31	0.15
EDUCATION AND AWARENESS	-0.14	0.17	0.59	0.30
GENDER ISSUES - Equity in education and training	-0.18	0.20	0.53	0.12
GENDER ISSUES - Women in institutions	0.64	0.25	0.09	0.10
TECHNOLOGY AND INVESTMENTS - Obsolete technologies, maintenance	0.17	0.22	0.43	0.05
TECHNOLOGY AND INVESTMENTS - Techno-economic barriers	0.30	0.18	0.32	0.36
HOUSEHOLDS - Water quantity - Over-abstraction of surface water	0.29	0.06	0.15	0.32
HOUSEHOLDS - Water quantity - Over-pumping of groundwater	0.21	0.00	0.17	0.52
HOUSEHOLDS - Water quality - Wastewater from households	0.61	0.13	-0.18	0.34
HOUSEHOLDS - Water quality - Uncontrolled solid waste disposal	0.54	0.07	0.11	0.06
HOUSEHOLDS - Water quality - Groundwater contamination (households)	0.65	0.21	-0.09	0.31
HOUSEHOLDS - Water quality - Groundwater contamination (waste dumps)	0.64	0.22	-0.20	0.15
HOUSEHOLDS - Water saving technologies	0.65	-0.10	0.10	0.29
HOUSEHOLDS - Impacts of population growth	0.84	-0.13	-0.01	0.32
TOURISM - Water quantity - Surface water demand by tourism	0.87	0.12	0.17	0.04
TOURISM - Water quantity - Groundwater demand by tourism	0.86	0.11	0.17	0.03
TOURISM - Water quality - Surface water pollution by tourism	0.83	0.11	0.21	-0.01
TOURISM - Water quality - Groundwater pollution by tourism	0.84	0.16	0.19	-0.03
TOURISM - Water saving technologies	0.87	0.10	0.18	0.06
TOURISM - Increasing demands by sectoral growth	0.86	0.10	0.07	0.07
AGRICULTURE - Water quantity - Surface water demands	-0.07	0.37	0.29	0.66
AGRICULTURE - Water quantity - Groundwater demands	0.03	0.33	0.31	0.65
AGRICULTURE - Water quality - Surface water pollution by agriculture	0.10	0.51	0.09	0.57
AGRICULTURE - Water quality - Groundwater pollution by agriculture	0.18	0.55	0.12	0.55
AGRICULTURE - Water technologies (irrigation efficiency)	0.47	-0.04	0.16	0.39
AGRICULTURE - Agricultural expansion	0.57	0.24	0.02	0.38
INDUSTRY - Water quantity - Surface water use by industry	0.62	0.07	0.41	0.16
INDUSTRY - Water quantity - Groundwater extractions by industry	0.67	0.09	0.46	0.22
INDUSTRY - Water quality - Surface water pollution by industry	0.51	0.06	0.55	0.19
INDUSTRY - Water quality - Groundwater pollution by industry	0.61	0.06	0.59	0.26
INDUSTRY - Water saving technologies	0.59	0.03	0.56	0.25
INDUSTRY - Impacts of industrial growth	0.52	-0.02	0.48	0.28
OTHER USES (environment, shipping, flood control) - Environmental water allocation	-0.11	0.34	0.09	0.09
OTHER USES (environment, shipping, flood control) - Flooding	0.27	0.00	0.30	-0.07
QUANTITY - Conflicts from limited surface water	0.11	0.76	0.21	-0.01
QUANTITY - Conflicts from limited groundwater	0.08	0.76	0.20	-0.06
QUANTITY - Alternative water resources	0.37	0.01	0.37	-0.15
QUANTITY - Dependency on water imports	0.52	0.10	0.03	-0.09
QUALITY - Surface water quality	0.42	0.40	0.23	0.10
QUALITY - Groundwater quality	0.51	0.56	0.24	-0.06
QUALITY - Limits to domestic use	0.28	0.59	0.32	0.21
QUALITY - Limits to recreational use	0.17	0.20	0.73	0.28

QUALITY - Limits to agricultural use	-0.04	0.44	0.69	0.13
QUALITY - Limits to industrial use	0.44	0.15	0.71	0.10
INFRASTRUCTURES - Abstraction, reservoirs, water harvesting	0.20	0.40	0.40	-0.09
INFRASTRUCTURES - Sanitation: sewers and treatment	0.66	0.43	0.03	0.06
INFRASTRUCTURES - Distribution losses (canals, pipes)	0.31	0.59	-0.17	0.02
INFRASTRUCTURES - Preservation of natural resources - Impact of infrastructures on biodiversity	0.43	0.48	-0.14	-0.15
INFRASTRUCTURES - Preservation of natural resources - Prevention of natural disasters	0.50	0.21	-0.02	**-0.44**

Table 14 Water Issue Questionnaire: factor analysis – four factor (MINRES factoring method applied to the polychoric correlation matrix). The same chromatic code as in Table 10 is used.

Water Issue	1^{st} factor	2^{nd} factor	3^{rd} factor	4^{th} factor	5^{th} factor	6^{th} factor	7^{th} factor	8^{8h} factor	9^{th} factor	10^{th} factor	11^{th} factor
Institutional 1	**-0.34**	0.18	0.68	-0.03	0.19	0.09	0.06	-0.01	-0.01	-0.01	0.21
Institutional 2	**-0.38**	0.01	0.67	0.17	0.19	0.01	-0.09	-0.08	0.09	0.23	0.00
Institutional 3	0.20	-0.17	0.14	0.16	0.40	0.05	**-0.31**	0.04	-0.20	-0.01	0.09
Regulatory 1	0.03	0.32	0.50	0.16	0.12	0.27	-0.11	0.01	-0.02	-0.03	0.04
Regulatory 2	0.08	0.04	0.59	0.09	0.26	-0.01	0.05	0.04	-0.12	-0.16	0.15
Regulatory 3	0.28	0.13	-0.08	-0.02	-0.02	0.07	0.03	0.69	0.04	0.08	0.10
Pricing 1	0.01	-0.06	0.21	0.06	-0.11	-0.25	**-0.55**	-0.27	-0.14	0.09	0.09
Pricing 2	0.15	0.30	0.25	-0.05	0.11	0.26	0.33	0.01	0.04	0.02	-0.12
Pricing 3	0.20	0.17	0.53	0.06	0.04	-0.01	-0.00	-0.20	0.06	0.04	-0.14
Education	-0.04	0.28	0.51	-0.02	-0.03	-0.13	0.29	0.29	0.01	0.42	-0.05
Gender 1	-0.10	0.35	0.36	-0.07	0.18	-0.09	0.07	0.15	-0.29	0.46	0.14
Gender 2	0.55	0.12	0.11	0.23	0.23	0.12	0.01	0.38	-0.13	0.05	0.08
Technology 1	0.10	0.30	0.19	0.47	-0.07	-0.07	0.16	-0.07	0.14	0.18	0.22
Technology 2	0.23	0.21	0.10	0.28	0.15	-0.01	0.18	0.04	0.49	0.15	0.13
Household 1	0.18	0.05	0.11	-0.06	0.11	0.06	0.02	0.34	0.56	-0.05	0.23
Household 2	0.13	0.31	0.00	-0.05	0.24	0.06	0.18	-0.03	0.53	-0.06	-0.09
Household 3	0.49	0.01	-0.05	0.05	0.15	0.63	0.13	0.07	0.07	0.10	-0.03
Household 4	0.30	0.18	0.06	-0.11	-0.09	0.49	-0.21	0.12	0.24	-0.05	0.51
Household 5	0.47	0.10	0.05	0.02	0.16	0.69	0.06	0.16	-0.03	-0.01	0.04
Household 6	0.45	-0.01	0.01	0.10	0.05	0.68	-0.07	0.08	0.04	-0.15	0.18
Household 7	0.42	0.24	-0.03	-0.07	-0.10	0.30	0.06	0.63	0.20	-0.09	-0.11
Household 8	0.74	0.26	-0.18	0.03	0.04	0.26	0.09	0.17	0.10	-0.21	0.03
Tourism 1	0.88	0.22	0.06	0.08	0.06	0.13	-0.07	0.14	0.07	0.04	0.03
Tourism 2	0.87	0.28	0.08	0.07	0.03	0.12	-0.06	0.09	0.09	-0.05	-0.02
Tourism 3	0.90	0.17	0.04	0.15	0.03	0.06	-0.02	-0.02	0.11	0.15	0.09
Tourism 4	0.82	0.20	0.07	0.16	0.00	0.14	-0.08	0.07	0.19	0.02	0.05
Tourism 5	0.83	0.25	-0.05	0.04	0.08	0.20	-0.11	0.15	0.05	0.00	0.12
Tourism 6	0.88	0.17	0.03	0.00	0.11	0.16	-0.04	0.07	0.01	-0.17	0.03
Agriculture 1	0.06	0.15	0.54	-0.08	0.43	-0.13	0.37	0.13	0.16	0.01	-0.09
Agriculture 2	0.08	0.33	0.44	-0.14	0.44	0.00	0.31	-0.03	0.10	-0.04	-0.14
Agriculture 3	0.07	0.11	0.24	0.16	0.78	0.10	0.08	-0.04	0.25	0.10	-0.01
Agriculture 4	0.12	0.20	0.36	0.05	0.70	0.15	0.03	0.01	0.13	-0.03	-0.04
Agriculture 5	0.42	0.17	0.04	0.26	-0.05	0.05	0.49	0.26	0.15	0.02	0.19
Agriculture 6	0.47	0.29	0.09	0.21	0.38	0.03	0.12	0.11	0.10	**-0.50**	0.01
Industry 1	0.46	0.61	0.04	0.18	-0.01	0.21	-0.03	-0.09	0.24	-0.03	-0.02
Industry 2	0.56	0.57	0.11	0.09	0.04	0.17	-0.03	-0.02	0.28	0.06	-0.03
Industry 3	0.35	0.66	0.04	0.20	0.06	0.05	0.07	0.19	0.03	0.04	0.11
Industry 4	0.46	0.75	0.09	0.15	0.09	0.03	0.07	0.20	0.02	-0.02	0.04

Industry 5	0.45	0.62	0.03	0.01	0.18	0.06	0.11	0.27	-0.02	0.05	0.23
Industry 6	0.36	0.65	0.02	0.12	0.05	0.09	0.17	0.11	0.08	-0.22	0.19
Environment	0.07	-0.07	0.50	-0.05	-0.07	0.16	0.12	-0.26	-0.07	0.13	0.03
Flooding	0.14	0.19	-0.02	0.02	0.01	0.08	-0.09	0.05	0.05	0.05	0.67
Conflicts 1	0.15	-0.10	0.80	0.34	0.05	-0.10	-0.12	0.19	0.14	0.06	-0.02
Conflicts 2	0.07	0.03	0.72	0.30	0.11	-0.06	-0.24	0.09	0.09	-0.03	-0.14
Alternative	0.34	0.28	0.20	-0.13	-0.25	-0.09	-0.26	0.09	0.21	-0.02	0.06
Imports	0.41	0.32	-0.05	-0.03	0.11	0.16	**-0.42**	0.08	-0.03	-0.04	**-0.37**
Quality 1	0.25	0.09	0.17	0.30	0.14	0.16	-0.14	0.35	0.23	0.39	0.08
Quality 2	0.28	0.25	0.33	0.25	0.10	0.29	-0.33	0.17	-0.01	0.13	0.14
Quality 3	0.08	0.42	0.38	0.25	0.44	0.18	-0.26	0.00	0.10	0.00	0.07
Quality 4	0.21	0.58	0.37	-0.06	0.22	-0.08	0.05	-0.16	0.19	0.33	0.19
Quality 5	-0.08	0.46	0.49	0.14	0.13	0.00	-0.13	-0.05	0.26	0.41	0.08
Quality 6	0.32	0.71	0.22	0.10	0.06	-0.02	-0.13	0.11	0.13	0.15	-0.01
Infrastructure 1	0.01	0.34	0.16	0.62	0.09	-0.09	-0.10	0.06	-0.02	0.11	0.12
Infrastructure 2	0.53	0.18	0.13	0.54	0.14	0.38	-0.01	-0.10	-0.11	0.06	-0.03
Infrastructure 3	0.20	0.02	0.22	0.73	0.13	0.18	-0.09	-0.11	0.04	-0.25	-0.19
Infrastructure 4	0.37	-0.05	0.23	0.49	0.15	0.03	-0.25	0.18	-0.11	-0.21	-0.21
Infrastructure 5	0.34	0.04	-0.09	0.19	-0.05	0.15	**-0.61**	0.19	-0.03	-0.03	0.13

Table 15 Water Issue Questionnaire: same as Table 10 but eleven (instead of four) factors are extracted.

Part III Socio-economic analysis: issues and indicators

1. Introduction

The statistical analysis of the replies to the Water Issues Questionnaire has provided a most useful means to document the perceptions held by the different stakeholders across the 7 OPTIMA case studies.

Some of the findings suggest, rather strongly, that it is equally important to establish a ranking of the problem issues that would be derived solely from factual information.

Consequently, such an independent dataset could then be assessed further in the context of possible 'development scenarios', with a view to demonstrate through the use of appropriate modeling tools how conflicts (some of which could indeed be the result of ill-perceived priorities assigned to the water issues by the different stakeholders) could be reconciled in the context of a sustainable approach to water resources management.

With regard to construction of plausible development scenarios, the OPTIMA Technical Annex distinguishes between 5 driving forces: **demographic change, economic development, land use change, technological change, and institutional change.**

In order to integrate and implement these driving forces in the context of the simulation and optimization models (which is the objective of WP06 "Systems integration and implementation"), the focus here is on establishing a set of indicators covering the socio-economic aspects of water resources research – and practical valuation methods for these indicators – that could provide an independent dataset.

A detailed assessment of two of the above driving forces, i.e. technological change and land use change, are the object of specific workpackages in OPTIMA. Indeed, it is reminded that WP02 runs in parallel, not only with the development of the analytical tools (WP03), but also with WP04 "Techno-economic data compilation and analysis" and WP05 "Land use change: Remote sensing and GIS data".

Although these latter workpackages are scheduled for completion at a much later date (relative to WP02), it is considered worthwhile to anticipate the possible requirements for the integration and eventual implementation of the different inputs from a socio-economic perspective.

2. Integrated assessment of driving forces

This section presents a review of the five driving forces for the construction of plausible development scenarios. For each of these driving forces, possible indicators are defined, together with their respective valuation method. Particular attention is given to further elaborate on the socio-economic indicators and how these are taken up in the assessment criteria by each of the driving forces.

2.1 Technological change

The compilation, analysis, and processing of techno-economic solutions, will be the basis of the optimization part of different water management scenarios, executed by the case study specific users.

The construction of a database is essential for the particular task, since it will describe alternative water technologies, their costs and efficiencies, that the optimization algorithms can configure to meet constraints and maximize or minimize objectives.

Database Structure

Although the structure of the database is at the time of writing this report still in an 'evolution' phase, it will be designed to contain the following:

- The main file directories, that include the alternative water technology options as presented below:
    a) Supply options (technologies that reduce water losses)
    b) Demand options (technologies that can serve the same demand with less water consumption etc.)

- Subdirectories that index the different water saving methods or technologies proposed.

  Each subdirectory includes an excel file containing techno-economic information about the mentioned water technology option. Each excel file contains the following:

    a. 'Descriptive' Sheets, which outline the implementation steps of the particular technology that is proposed, together with the respective field units that have to be filled in by the case study user in each cell.

    b. 'Alternative' Sheets, with each of these sheets describing different methods/types of a particular water technology (e.g. channels can be lined using concrete, compacted earth and geo-membrane, piping can be done using concrete, PVC pipes, etc.).

       The sheets forming the excel file will follow a specific structure as described below:

1. NAME of the technology (short, < 16 characters)
2. DESCRIPTION of the technology (free text, e.g., 1024 characters)
3. DATES of creation and last modification (automatically updated)
4. LOCATION (case study, can be GENERIC for all case studies)
5. YEAR (the reference year the data are valid for)
6. DOMAIN (select from structures, demand, supply, allocation, quality)
7. IMPLEMENTATION STEPS
8. COSTS
9. TOTAL ANNUAL COSTS
10. ANNUAL COSTS PER m3 OF WATER SAVED
11. CAPITAL RECOVERY COSTS
12. WATER BENEFITS (see also scenario evaluation below)
13. INFORMATION SOURCE-AUTHOR

c. Finally a sheet named 'INPUT DATA', will index the information that has been introduced by the user, for the model to run the scenario.

Data Base Development Steps

The general approach concerning compilation, analysis, processing and scenario optimization, can be summarized as following:

1. Initial approach regarding the database structure development will be to draw up a detailed proposal for the database structure-fields-representation.
2. Start the compilation and organizing of the generic information by looking into water saving measures.
3. Develop a few examples as a starting point.
4. Set up an on-line database.
5. Invite the case study partners, who will eventually utilize the database, to enter some case specific data to the examples provided, such as local costs.
6. Collect the feedback response from the case study partners.
7. Further amelioration of the database structure, especially to ensure that the structure satisfies the requirements of the water management model.
8. Filling up the database and finally completing the web-based, water technology database.

Scenario Evaluation Issues

<u>Cost - water benefit analysis</u>

The OPTIMA water management DSS will be able to provide a detailed evaluation framework for the various water management scenarios, run by the case study users. The database will provide a large number of water saving measures that are usually practiced globally. The DSS will be able to determine the cost effectiveness of each measure after the scenario running.

The cost benefit ratio, based strictly on water conservation effectiveness, will basically calculate the benefits of a water management measure by estimating the reduction in water demand, or the water saving that would result from the application of the measure, and compare this to the costs of implementing the particular measure.

The cost analysis will be according to an annualized cost estimate, that takes into account the annual capital, operation and maintenance costs, interest rate and project life of the proposed measure.

Other issues

Selecting the most appropriate water saving measure is a complex process. Apart from the cost – water benefit analysis that will be performed by the DSS model, there are a number of other factors that should be looked into carefully when selecting the most appropriate water management measure for a particular area.

Most of the proposed water measures carry limitations in terms of their applicability, and some "promising" measures may not necessarily be appropriate for the entire case study area, but only parts thereof.

During the scenario running process, the case study partners should, in active consultation with the stakeholders and endusers, give due consideration to issues including:

- **Economic** (Capital and O & M) issues
    - Ability to cover the cost required for the implementation and operation and maintenance of the proposed water saving technology

- **Legal** issues
    - Sustainable water use should be according to local and/or national legislation (water quality standards, water rights and environmental legislation)

- **Social** issues
    - Safety and community acceptance
      Safety is a concern among the public. These concerns can be alleviated using safety measures and proper design features.
    - Living conditions, economic development, employment, and other social welfare effects resulting from water-related measures need also to be considered.
    - Current land uses - Future development
    - Property Values and Public Perception
      The impacts of water saving measures on property values are site-specific. The presence of a structure can affect property values in one of three ways: increase the value, decrease the value, or have no impact.
    - Visual aesthetics of water measure. Aesthetic maintenance is also important when considering long term impacts on property values.
    - Odor problems

- **Political** issues

- **Environmental - Ecological** issues

    - Recreation effectiveness. In many cases, recreation may be developed adjacent to such areas of water management structures
    - Wildlife habitat impacts
    - Biodiversity impacts
    - Chemicals usage needs

- **Engineering** - practical issues – **Site Specific** applicability requirements

    - Site suitability for selecting a particular water management strategy is key to successful performance.
    - Availability of land - space
    - Soil type - geology/topography
    - Groundwater depth
    - Site slope
    - Periodic and long-term maintenance/rehabilitation/labor needs
    - Training needs
    - Life time/reliability of proposed measure
    - Susceptibility to climate…etc.

The combination of these factors, which can affect the design, performance and acceptability at the local (down to the site-specific) level, makes the selection of a(ny) appropriate water measure a difficult task, which should therefore be made by experienced water practitioners - in active consultation with local stakeholders and endusers.

It can be concluded – on the basis of the above information – that technological change (as a driving force for plausible development scenarios) will be assessed through the compilation of a database of water saving measures and their associated costs.

A cost – water benefit analysis will be an integral part of the software developed in WP03 'Analytical tools: simulation and optimisation models', while the need for an active consultation with stakeholders and end-users is highlighted to assess the impact of the factors that have been listed above at the local (down to the site-specific scale).

2.2 Landuse change

Knowledge of the spatial distribution of land use / land cover information and its changes is needed for the planning, management and monitoring of water resources projects and programmes. Planning involves the assessment of future development needs and making provisions for these needs. To ensure sustainable development, it is essential that changes in the land use pattern are monitored over a period of time. Remote sensing techniques and GIS play a vital role in establishing such land use change patterns and guide the assessment of the impacts, associated with land use change, on the water resources.

Apart from natural (climate) causes, the driving forces of land use change / degradation that are relevant also to the socio-economic framework analysis, include:

- Increase in population growth
- Migration from rural to urban areas
- Neglecting of agricultural areas (leading to soil erosion etc.)
- Excessive use of natural resources (water, forest, mining etc.)
- Infrastructural development (new settlements, roads, dams etc.)
- Use of new technologies (including water saving measures)

Consequently, land use change patterns reflect (mirror) the impacts of demographic change, economic change, technological change and institutional change, on the water resources and its development over time.

Land Use Change – Database structure

The GIS database for the 7 case studies will comprise the following data:

1. **Time series data:** "satellite imageries" of the study area within a period of 15 years would be undertaken through the process of change detection

2. **DEM:** to ensure the good overlay processing and referencing for different data sets "Ortho-rectification", morphological distribution, drainage network extraction & sub-catchments identifications

3. **Ancillary data:** Topographic maps, water management issues, hydrogeological data climatic data, socio-economical information, demographic developments, etc.

4. **Metadata:** ISO/TC211: International standards Organization, developed a family of standards ISO 19115.

In the above structure, socio-economic data are included with 'Ancillary data'. In particular, it is envisaged to include data on water consumption and water tariffs associated with domestic, recreational, agricultural and industrial use.

A distinction can be made also between the direct and indirect data requirements. The former include time series data in the form of multi-temporal imageries, a digital elevation model and the Corine (land use) classification. Indirect data requirements include river basin objects such as the sub-catchments of the case study areas, meteorological and hydrological data, data on water quality and on water economics.

Table 1 below looks at the different types of Vector Data (comprising Point, Line and Polygon feature data) that will be taken up in the GIS for each of the case study areas.

Point feature data	Line feature data	Polygon feature data
•Villages •Springs •Wells •Pluviometric stations •Gauging stations •Pollution sources •Artificial water tanks •Elevation points	• Drainage networks • Road networks • Contours • Fault lines	•Area location **•Cadastral/municipality** boundaries •Hydrogeology •Geology •Soil •Pluviometry •Settlement expansion •LUC (land cover/use) •TIN

Table 1 Different types of Vector Data considered

Attribute data, relevant to the socio-economic context, are foreseen in relation to the Villages and Cadastral/municipality. Examples of already foreseen attributes include:

- *Vill_Char:* This field will take either "U" or "R" value indicating that the Village is considered an either urban or rural respectively

- *Pop_Year:* This could be as many population data as we have on yearly basis (e.g. Pop_ 1996, Pop_2002, etc.)

- *Pop_Density*: This field indicates the number of people / Km2.

Land Use Change Model

To apply the Land Use Change (LUC) Model in water resources, data is compiled via Remote Sensing and GIS, and standardized. A direct observation of the landuse change is obtained through the CORINE Land Use classification- Level 3, while an indirect observation is gained through assessing the effect of LUC on water resources modeling (WRM) and river run-off modeling (RRM).

The Land Use Change Model is a dynamic model that affords space, time and system attributes, and will be based on the following:

- The spatial dimension is represented as a set of discrete areal units (land use classes based on the CORINE classification)
- Transition rules which are the actual driving forces behind the model dynamics
- Functions which serve as algorithms which code real-world behaviour into the artificial “raster” world

- Time or temporal resolution which maintains the uniform application of the transition rules.

With regard to the socio-economic context, it is envisaged that the socio-economic data can be either added or joined from the existing database (see above). For example, once a plausible water development scenario has been agreed up, its Land Use Change impact could be extended to include the cost of operation and maintenance, environmental costs etc.

It is also at this point that it becomes feasible to assess the impact also of possible changes in the institutional and regulatory framework, including the impact of policies, programmes and regulations.

2.3 Demographic change

Demographic and migration issues and projections (evolution of the variables birth, death, migrations and the trends observed in the past) should obviously be taken up as prime driving forces in the scenarios that will be developed for each of the case studies.

The valuation of these indicators is usually available from National Statistics Offices (see Appendix 1 for the website addresses of the Statistics Institutes for the 7 partner countries in OPTIMA with a case study area).

However, the physical boundaries of the case study areas (river basins) commonly do not coincide with the zonation (provinces, regions etc.) according to which the statistical data are aggregated.

Although this does seem to present a serious difficulty for the case studies under investigation, it can be pointed out that through remote sensing techniques and GIS, the land use and land use change detection can provide a useful means to estimate population and population densities.

As explained earlier, the demographic growth and migration issues are explicitly taken up under the header ‘ancillary’ data in the GIS that is being developed in each of the case studies for the purpose of land use change modelling.

2.4 Economic development

Similar to what was discussed in the previous section, data documenting the level and pattern of economic growth (GDP, employment statistics etc. on a sectoral basis: domestic, tourism, agriculture and industry) are commonly obtained from National Statistics offices, while the attention should be drawn to the (likely) mismatch between the physical boundaries of the river basins (case study areas) and the zonation according to which the data on economic development are aggregated and readily obtained.

At the same time, it is well recognized that the level and pattern of economic growth leads to shifts in sectoral demand for water. This differential development of different economic sectors is reflected in land use change (and hence water use), but also in the overall distribution of value added from use of water as primary input.

There is ample scope therefore to consider making use of the 'best available' distribution in both space and in time of the data on economic development, and to assess the documented shifts (in the dataset that can be more readily obtained from the statistics offices) with the changes in land use observed through remote sensing techniques.

It is also reminded that the level of economic development may present a barrier to the uptake of new water technologies, in terms of ability to cover not only the capital cost but also the operation and maintenance costs of the proposed water saving technology.

2.5 Institutional change

The Water Issues Questionnaire invited stakeholders to assess the impact of the "Institutional Framework" according to three distinct aspects, as shown in the Table 2 below.

2.1	INSTITUTIONAL FRAMEWORK
2.1.1	Institutional responsibilities
2.1.2	Active participation
2.1.3	Private sector participation

Table 2 Institutional Framework "issues"

An independent valuation or appraisal of this issue (independent from the perception of the stakeholders) could be considered using key questions, such as:

2.1.1 Institutional responsibilities
- How many institutions are involved ?
- Is there a clear division of responsibilities ?

2.1.2 Appraisal of Stakeholder participation
- Is a mechanism in place that enables (encourages) stakeholder participation ?
- Do development applications require an EIA ?
- How effective is the role of NGOs ?

2.1.3 Appraisal of joint public – private involvement
- What (if any) is the role of private sector in water management ?

Although more detailed research would be required to document and asses the answers to the above questions in each of the 7 case studies, some general observations can be made.

A reduction in the number of institutions that are concerned with water management could be viewed as means to avoid overlapping or conflicting responsibilities. A more important improvement in the institutional framework could be achieved however, with the introduction of direct lines of communication and cooperation between the different organizations, departments and agencies that are directly or indirectly involved with the management of water resources. It is not uncommon that data collected by individual organizations are not readily accessible or available to other parties, but are seen as a means to retain the importance or control of one entity over another. It can be easily understood that this scenario deprives one and all from gaining better insights and knowledge not only of the water resources but also of the interdependencies between different natural resources (geology, soil, biodiversity, forest etc.).

The analysis of the response to the Water Issues Questionnaire indicated that, overall, local stakeholders consistently assigned lower ratings to the issues compared to the ratings given by the stakeholders operating at the national level. A priori, this could be viewed as an unexpected observation. Following from the discussion on the institutional framework, it could be considered that local stakeholders, including NGO's, may have considerably less access to data and information compared to the national stakeholders.

Also here, more detailed research would be required across the 7 case studies. Yet, from a general point of view it must be acknowledged that not only the number but also the position of the NGO's in North Africa and the Middle East has remained very modest. Both organizational and financial difficulties are the most likely reasons for this.

An increased participation of the private sector has been observed a result of decentralization efforts by national governments. In several of the case study areas, the decentralization of water supply and sanitation services has been assigned to the municipal level. In practice, however, the municipalities are frequently overburdened by this task. Owing to a lack of sufficient expert competence and qualitative and quantitative shortcomings in the availability of the equipment required, these services are delegated to private or public-private joint enterprises.

Evaluation and feedback mechanism

Ideally, as has been outlined for the driving forces discussed earlier (technological change, land use change, demographic change and economic development), the priority ranking assigned by stakeholders should be compared with an objectively assessed indicator value for the above 'institutional change' issues.

It remains doubtful that a sufficiently 'generic' valuation method, applicable across the different case studies, can be found for the institutional change indicators. Even the general observations that have been outlined above do not by themselves lead to precise criteria that could be readily taken up in the algorithms of the simulation and / or optimisation software modules.

However, what does appear feasible in the context of the OPTIMA project, is to encourage, through appropriate dissemination, the active participation of all stakeholders and endusers and to demonstrate the benefits that can be derived from the sharing of information. To this effect, a dissemination strategy is being elaborated in the context of WP16 Dissemination.

Following from this perspective, it can be argued that the possible obstacles to institutional change could be analysed more effectively in the context of a wider analysis of the decision-making process, which is discussed further in the section below.

3. Analysis of the decision-making process

In addition to the 'Institutional Framework' issues discussed earlier, the Water Issues Questionnaire has grouped the following issues as being relevant to the 'Water Management' sphere: 'Regulatory Framework', 'Water Pricing Policies', 'Education and Awareness', 'Gender Issues' and 'Technology and Investments'.

From a regulatory point of view, OPTIMA considers the EC Water Framework Directive (WFD) (2000/60/EC) as the main reference for sustainable water management at the EU scale. This Directive considers the River Basin as the fundamental unit for applying and coordinating the Directive's provisions. From the point of view of those responsible for river basin planning and management, a set of "Key Tasks" for implementing the Directive have been outlined (see WP01 'Requirements and constraints analysis' for a detailed list of these Key Tasks).

With regard to Water Pricing Policies, the Directive calls for the provision of adequate incentives for efficient use of water taking into account the principle of "cost recovery" for water services, including environmental and resource costs.

From a 'Technology and Investments' point of view, OPTIMA envisages the construction of a database of water saving measures, which will be evaluated on the basis of a cost – water benefit analysis.

While this defines a set of objectives including economic efficiency, a truly multi-objective and multi-criteria approach requires the consideration of a broader range of issues. Most importantly, the implementation of any optimal strategy or solution is going to require the acceptance by the stakeholders and actors in the decision-making process. In the discussion on 'Technological change' as a driving force for plausible development scenarios, an exhaustive list of possible barriers to the implementation of a(ny) techno-economically optimal solution has been presented which, not surprisingly, advises on social and economic barriers. It is pointed out that such barriers cannot be readily taken up in the cost – water benefit analysis, but must be taken into consideration and assessed through direct consultation with the stakeholders.

In order to integrate a 'decision-making' analysis in the context of OPTIMA, it is proposed to incorporate different management scenarios into '**water demand management options**', which may include singular - or multiple combinations of - water saving measures, changes in water tariffs, stricter water quality standards etc.), which can be (more) readily evaluated through simulation and optimisation software.

The detection and interpretation of land use changes (it is foreseen to assess the nature and extent of land use changes over the past 15 years through the interpretation with remote sensing techniques of multi-temporal imageries), is expected to provide valuable insight into the impact of current (or recently introduced) management practices. Knowledge on past trends can then be used to also project and visually demonstrate the effect of future development scenarios.

Clearly, an active consultation with the stakeholders to first establish future development scenarios will be an important asset towards gaining the acceptance of the stakeholders of any ‘optimum’ management solutions. To this effect, a number of participatory workshops with stakeholders are already being envisaged at the time of writing this report.

From a dissemination point of view, these workshops should also be viewed as a means through which OPTIMA will contribute to an increased awareness on water management research and on the possible benefits that can be derived from the application of water management optimisation tools.

4. A look ahead

The consideration of socio-economic issues in water management planning is one of the most important prerequisites for a sustainable water use. Economic efficiency and social harmony are key socio-economic targets.

Initial efforts aimed at gaining stakeholder involvement have been the object of a Water Issues Questionnaire, and are currently being followed up with the design and elaboration of participatory workshops in selected case study areas.

In line with one of the key tasks taken up in the EC Water Framework Directive, the OPTIMA dissemination strategy is centered on actively involving interested parties such as relevant government departments, local communities, water utilities, industry and commerce, agriculture, consumers and environmental groups throughout the project lifecycle.

Appendix 1 STATISTICAL INSTITUTES WEBSITES IN PARTNER COUNTRIES WITH CASE STUDY IN OPTIMA

Cyprus
Department of Statistics and Research: http://www.pio.gov.cy/dsr/

Jordan
Department of Statistics: http://www.dos.gov.jo/

Israel:
Central Bureau of Statistics: http://www.cbs.gov.il/

Lebanon:
Administration centrale de la Statistique: http://www.cas.gov.lb/

Morocco:
La Direction de la Statistique: http://www.statistic.gov.ma/

Palestinian Authority
Central Bureau of Statistics: http://www.pcbs.org/

Tunisia:
L'Office national de la Statistique: http://www.ins.nat.tn/

Turkey:
State Institute of Statistics: http://www.die.gov.tr