



## **Indicators and Thresholds for Desertification, Soil Quality, and Remediation**

A specific targeted research project within the  
sixth framework programme  
(global change in ecosystems)  
(GOCE-CT-2003-505450)



# **PROJECT DESCRIPTION**

**8.11.2004**

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## 1. Project summary

Land degradation (including desertification) is a paramount international problem, and indicators have been developed to follow it. Many are based on (1) plant communities, or (2) soil loss, or (3) salinity. They tend to monitor the status quo over large time periods and are more suitable for crisis assessment than for risk prevention. They are also poorly suited for the sensitive monitoring of the success of remediation efforts. Last year the UN Convention to Combat Desertification (UNCCD) and other organisations have emphasised the continuing need for indicators. The mechanisms of land degradation are well known and have been the object of many EU studies. The prime goal of INDEX is to apply this knowledge to develop modern, rapid, sensitive, universal, multivariate indicators with which the dynamic state of land degradation as well as its remediation can be assessed. They will be based on: (1) microbiology including molecular biology and genetic diversity, (2) characteristics of the dynamic humus pool and humo-enzymes, and (3) soil physics including rheology. These indicators of desertification mechanisms will be developed on fields in various stages of degradation and remediation and verified on a pan European basis on sites selected with stakeholders. Results will be extrapolated to thresholds to indicate when remediation is economically unfeasible. INDEX is innovative, since it (1) is based on mechanisms, (2) is holistic, and (3) introduces novel parameters. In view of Global Change such indicators are especially needed. Changes will often be slow and subtle. An early warning system is needed to indicate the need for countermeasures, while they are still economical. INDEX will rely on previously supported Commission projects and will disseminate its results to subsequent projects. It will attempt to utilise small and medium enterprises (SMEs) as links to non-scientific institutions. The whole will be imbedded within the UNCCD and disseminated to stakeholders.

## 2. Background

This project (Indicators and Thresholds for Desertification, Soil Quality, and Remediation, with the acronym INDEX) was initiated in response to the 1<sup>st</sup> call within the Global Change in Ecosystems Program of the 6<sup>th</sup> Framework of the European Commission (EC). It was specifically designed to fulfil the EC's request for a specific targeted research project (STREP) dealing with:

“Research on mechanisms of desertification and soil quality. To investigate how land degradation mechanisms affects the critical soil functions that are necessary for maintaining and restoring soil and land quality, and ecosystem health. It is necessary to define the thresholds and critical factors of degradation in order to allow successful restoration action and enable an early warning system. Develop and demonstrate ecotechnological innovation applied to land degradation management as methods and tools for land care and mitigation of desertification.”

INDEX had a start date of 01/01/04 and is to run 36 months with an EC contribution of 1.399.955 € It is composed of the following consortium (The organisation abbreviations are in bold):

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### 3. Project execution

INDEX is composed of 7 workpackages (WP). They and their interactions are given in Fig. 1. The time schedule for their execution can be found in Table 2.

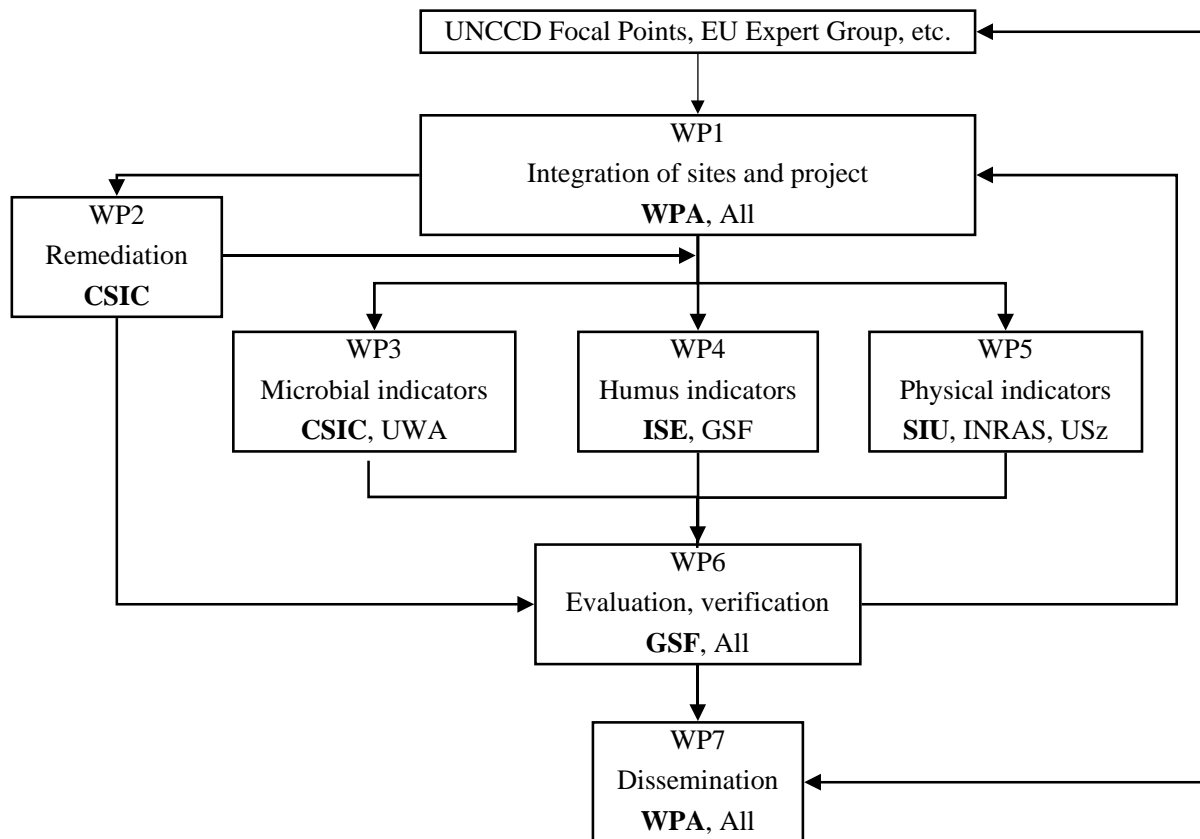


Fig. 1. Interdependency of the work packages (WP). The partners involved in their realisation are also given in the boxes; the lead partner in bold. UNCCD is the United Nations Convention to Combat Desertification.

### Integration of sites and project (WP1)

This work package has the important overall task of integrating INDEX research into the framework of the EC and the UNCCD. The tasks are shown in Fig. 2. and consist of:

1. The establishment of contact with the stakeholders at the UNCCD, the EC, and other sources in order to obtain assistance and/or verification in the selection of research plots for the initial phase of the project;
2. The selection of research plots: The plots need to be representative of relevant to desertification and land degradation problems in the EU; and
3. The characterisation of the plots.

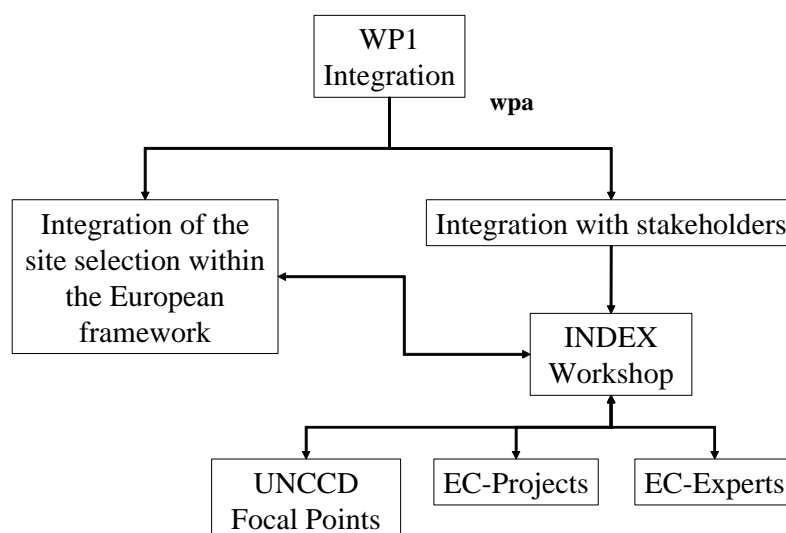


Fig. 2. Schematic illustration of the tasks of WP1.

The selected plots are given in Fig. 3 and Table 2. A detailed explanation can be found in the document “INDEX – Site Justification”, which can be found on the INDEX website [www.soil-index.com](http://www.soil-index.com).

Table 2. Research sites for the first phase of INDEX. Also cf. Fig. 3.

Country	Location	Treatment	Type of site
Germany	Puch	agricultural mismanagement and absence of vegetation	agricultural field
Hungary	near Gödöllő	erosion	agricultural catena
Italy	Basilicata	different agricultural practices under arid climate	agricultural field
	Tuscany	different agricultural practices under moderate climate	agricultural field
	Tuscany	underbrush removal	forests
Spain	Abanilla	erosion and mismanagement	catena
	Abanilla	different doses of OM for soil remediation	long-term plots
	Carcavo	revegetation	degraded forest catena
	El Aguilucho	remediation methods based on reforestation	long-term forest plots
	Santomera	deforestation	forest plots
	Tres Caminos	different treatments for soil remediation (OM addition, plants, and mycorrhiza)	short term plots
	Santomera	erosion and mismanagement	catena

OM is organic matter

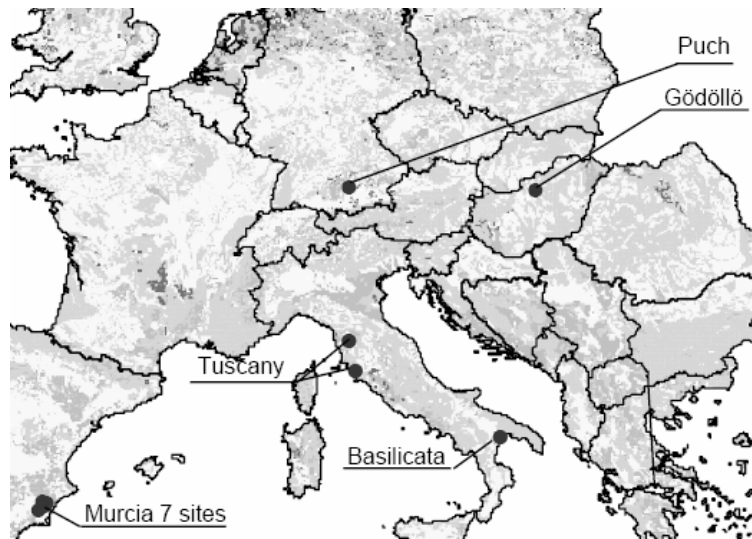


Fig. 3. Location of research sites during the first phase of INDEX.

### Remediation (WP2)

The goal of this workpackage is to test various remediation strategies. Some of these have been going on several years previous to the initiation of the project (El Aguilicho and Abanilla, cf. Table 2) while others are being initiated during the first year of the project (Tres Caminos). The remediation efforts (Fig. 4) are based mainly on:

- revegetation, especially reforestation,
- addition of organic matter,
- mycorrhiza inoculation or addition to soil, and
- addition of humus enzymes.

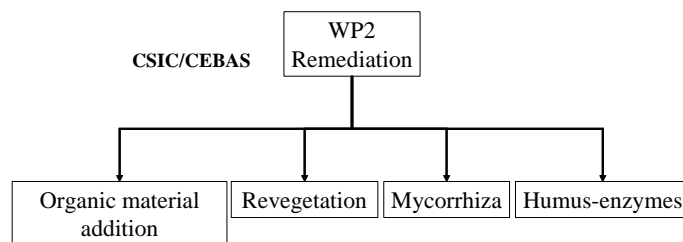


Fig. 4. Schematic illustration of the tasks of WP2.

### Microbial indicators (WP3)

From Fig. 5 it can be seen that a multifaceted approach is being used. Bulk functions such as microbial biomass carbon and basal metabolism are being measured while at the same time “traditional” enzymes such as urease, protease, dehydrogenase, etc. are also being determined. Furthermore more “modern” genetic methods such as PCR, DGGE, etc. are being applied to assess microbial diversity and functionality.

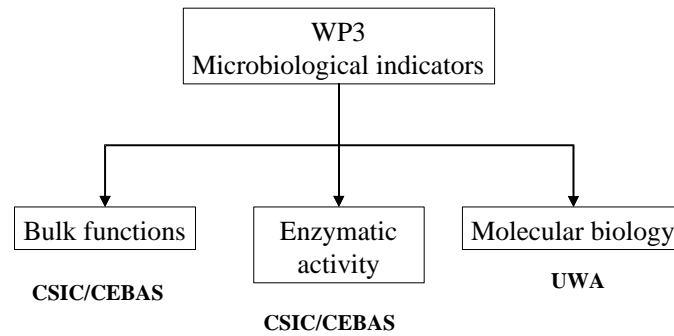


Fig. 5. Schematic illustration of the tasks of WP3.

**Humus indicators (WP4)**

Here also a multifaceted approach is being used to characterise various humus fractions (Fig. 6). The bulk humus is being characterised by pyrolysis gas-chromatography, but at the same time more specific fractions such as the humus-enzymes and the available humus are being investigated. The former are the immobilised extra-cellular enzymes and are a “crossing point” between microbiological and chemical soil processes. The latter is essentially the water dissolvable humus pool, which usually has the acronym of DOM. Not initially planned within the project was the determination of substrate (<sup>13</sup>C-glucose) utilisation. This however has now been incorporated, since it may also provide valuable information as to how the microbiota functions within soils of different quality.

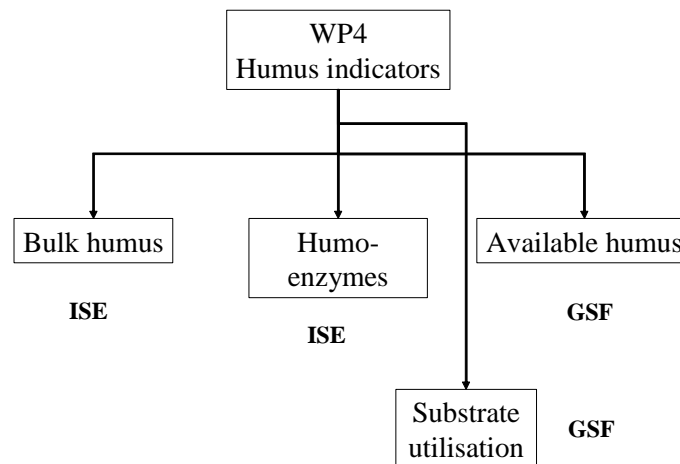


Fig. 6. Schematic illustration of the tasks of WP4.

**Physical indicators (WP8)**

The objective of this WP is to provide indicators for soil physical degradation properties that may lead to desertification. The parameters, which are being determined, are given in Fig. 7. Especially unique in studies of this kind is rheology, which tests the particle-particle network and strength in soils.

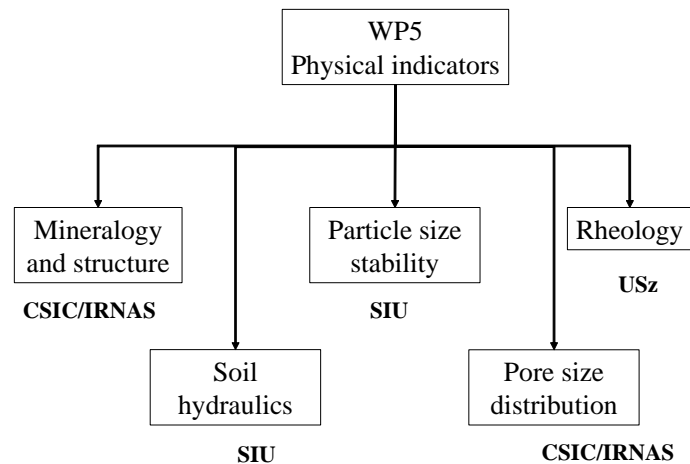


Fig. 7. Schematic illustration of the tasks of WP5.

### Verification (WP6)

The activities are illustrated in Fig. 8 and consist of:

1. The evaluation of all the accumulated data in order to develop an index, or more likely indicators, factors, or functions for desertification processes and remediation;
2. The testing of these indicators on remediated soils obtained from WP2; and
3. The verification, calibration, and upscaling of these indicators in other degraded and remediated European fields. SMEs, which produce soil improvement products, will be invited to participate in this activity;
4. An overall indicator assessment, which will then flow into WP7.

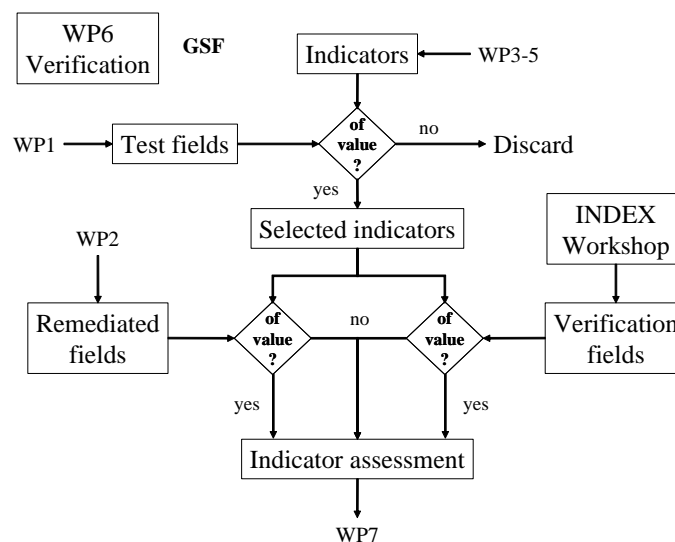


Fig. 8. Schematic illustration of the tasks of WP6.

An important concept is to determine how well the developed indicators can be used to determine threshold values, which are points at which remediation efforts are simply no longer justifiable economically (Fig. 9).

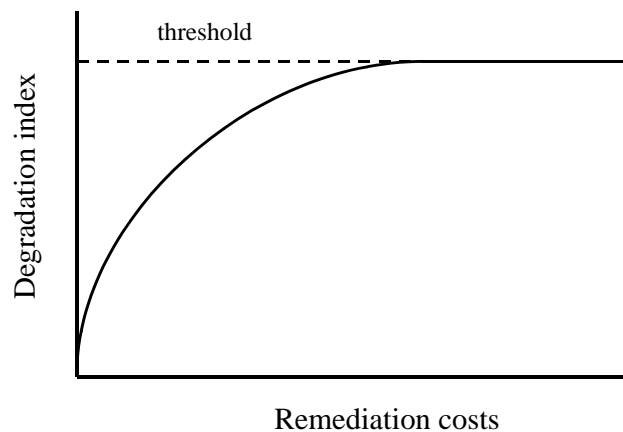


Fig. 9. Schematic illustration of the relationship between a degradation index and remediation costs.

**Dissemination (WP7)**

Within INDEX dissemination is a critical component, and its plans are presented within Fig. 10. A homepage is a key element and has already been established: [www.soil-index.com](http://www.soil-index.com). Efforts will and are being made to coordinate this with the portal [www.eu-medin.org](http://www.eu-medin.org).

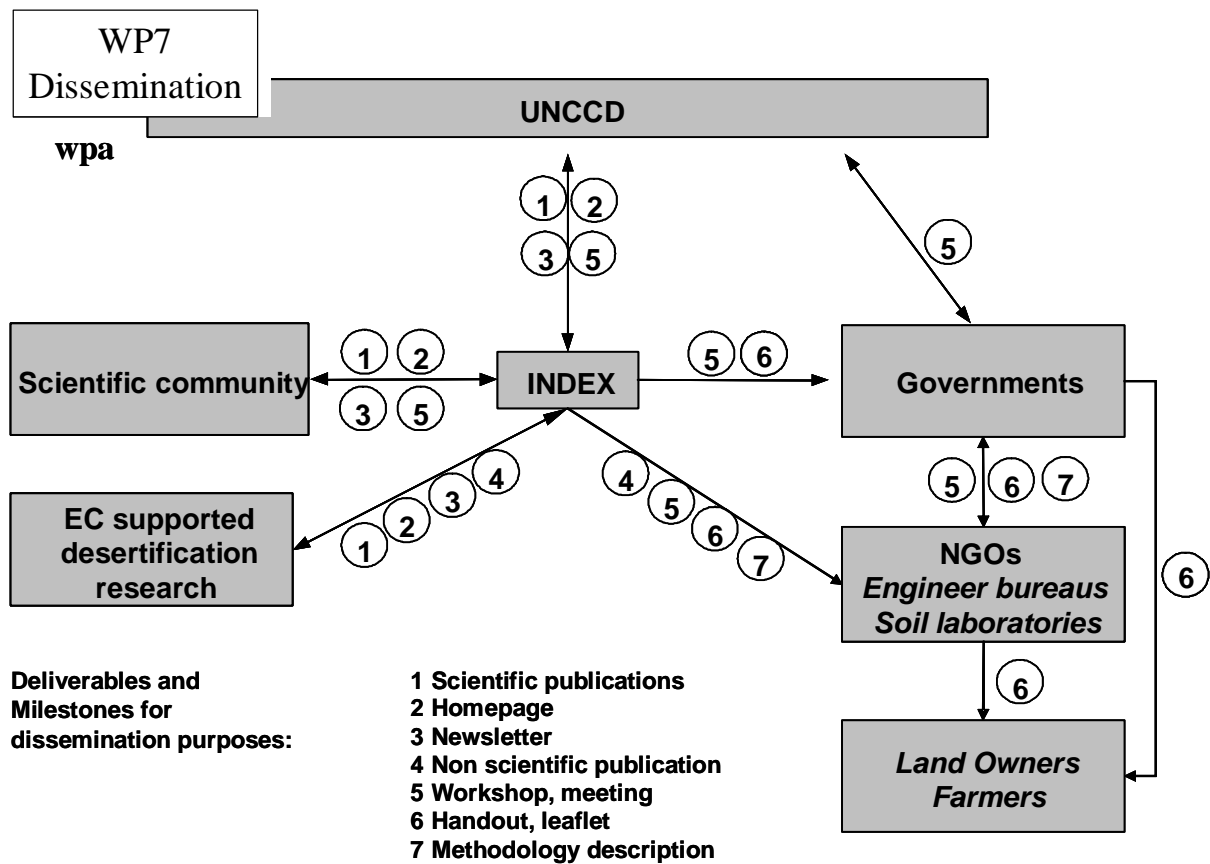


Fig. 10. Schematic illustration of the tasks of WP7.

#### 4. Timetable

The time plan, within which the above WPs are to be executed, is given in Table 3.

year →	2004				2005				2006			
month →	3	6	9	12	15	18	21	24	27	30	33	36
Internet and dissemination (7)												
Project integration (1)												
Selected field sampling (1)												
Remediation studies (2)												
Microbiological indicators (3)												
Chemical indicators (4)												
Physical indicators (5)												
Evaluation and Verification (6)												

#### 5. Organisation

The chief organisational unit within INDEX is the Consortium Board consisting of all the WP leaders and of at least one member from each participating institute. Besides the general planning and execution of the project, it is also responsible for issues such as conflict resolution. The link to the EC is through the coordinator. INDEX in its planning and integration with other efforts in this area will also be assisted by an Advisory Board (Fig. 11).

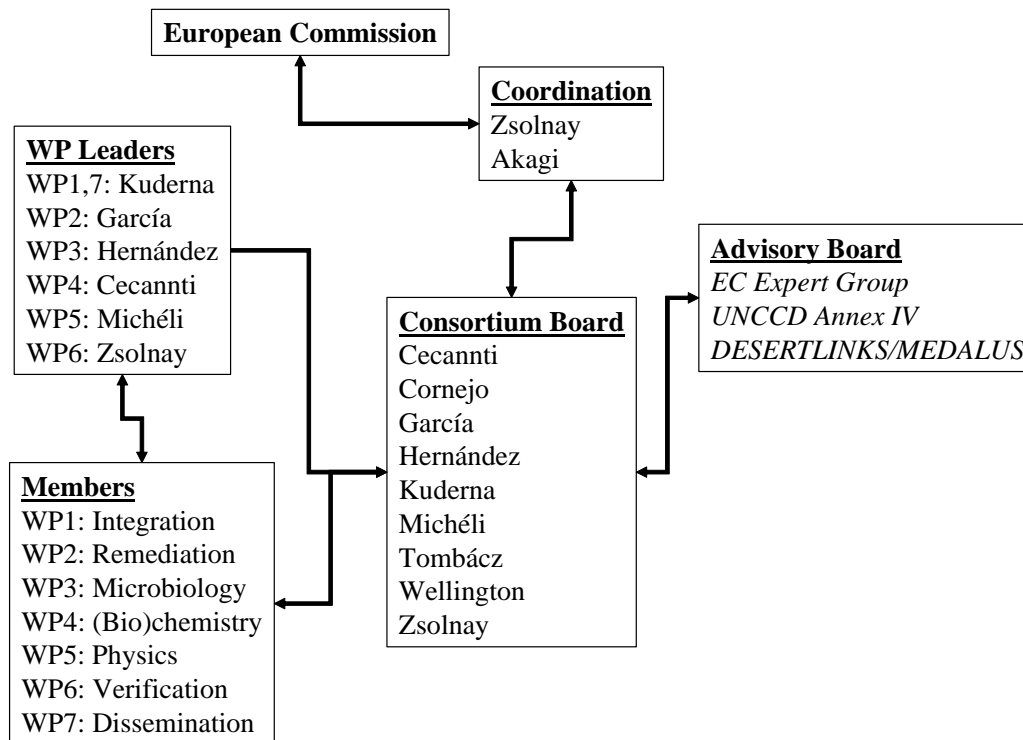


Fig. 11. Illustration of the organisation structure of INDEX.

## 6. Deliverables

Table 3 gives the list of deliverables within NDEX, which are of public interest.

Table 3. Deliverables of public interest and dates on which they are to be posted on the INDEX website <a href="http://www.soil-index.com">www.soil-index.com</a>		
Technical report with site justification	2004	February
Site description		March
Internet		March
Project presentation		April
Handbook on remediation strategies		June
Estimated remediation costs	2006	June
Preliminary indicator factors or functions		June
Remediated soil test evaluation		June
Cost-effect estimate of remediation measures		June
Verification study results assessment		September
Handbook of developed indicators		December

Any additional information in regards to INDEX can be either obtained from the website or by directly contacting:

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