THE MEDIAS DISTRIBUTED DATABASES FOR ENVIRONMENTAL INFORMATION. PLANNED APPLICATIONS TO CENTRAL ASIA ENVIRONMENTAL ISSUES

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Analysing and assessing environmental issues at any scale request a large number of data and information, either for purely research objectives or management and decision-making purposes. These are most often quite heterogeneous in terms of nature, processing level, format, location, ownership rules, etc... Nevertheless, having a friendly access to the whole set of requested information is quite mandatory to lead studies that take all relevant phenomena into proper account.

Examples of such information can be: information collected on ground about water, soils, vegetation; qualitative and quantitative socio-economic information; remotely sensed observations and derived parameters; climatic parameters. Such information can also be heterogeneous in terms of space and time scale and sampling. For instance, remote sensing allows a continuous monitoring with periodic revisit dates, ground truth information are collected at given times and places. Ground truth observations may be continuous in case of operational measuring stations, derived from periodic census or unique measurement experiments. Data may be easily available through dedicated and centralised organisations or poorly available and located in several widespread local centres. They may be free, commercial or even restricted.

In order to overcome such bottlenecks, MEDIAS–France developed sophisticated information management tools, making it available to the scientists of the MEDIAS network according to their needs. These tools are based upon metadata catalogues allowing to retrieve and access information in quite heterogeneous local databases according to internationally agreed standards. The management of the Aral Sea watershed environment information could be an excellent opportunity to take advantage of such tools.

The Aral Sea watershed is without contest a region facing one of the most severe anthropic environmental degradation in the world. Its main climate and ecosystems features evidence a fragile environment under water resource limitation pressure. Abundant water resources naturally flow from the Pamir mountains and associated watersheds to Aral Sea through Amou-Darya, Syr-Daria and tributary rivers. But the water availability significantly dropped in the past decade, imposing serious limitations on all water users (agriculture, industry, populated areas) and leading to the drying up of Aral Sea. The losses are determined by numerous factors, both natural (evaporation, filtration, etc.) and anthropogenic (culture of water use, quality of irrigation systems, etc).

Ambitious development decisions such as cotton intensive cultivation, implying major irrigation plans and use of chemical products (pesticides, fertilizers), undisputedly brought short term economic development, but undisputedly too brought ecological disasters such as soil and water salinisation and pollution, increased sensitivity to wind erosion, and Aral sea level dramatic decrease. This evidences a non-sustainable strategy on the long term (a time scale at which the global climate change has to be taken into account). Some disasters are certainly irreversible; others can be mitigated only through radical management practices changes

This is clearly a situation where a coupled approach between all relevant aspects of the natural and anthopogenic aspects of the situation has to be led. Taking note of that situation, some regional, European and international scientists and institutions decided to set up some initiatives to go forward and implement an integrated environmental approach at the whole watershed scale.

MEDIAS–France is in a position to offer to these scientists (i) its experience in networking and linking them to major scientific international initiatives (IGBP, IHDP, WCPR, DIVERSITAS, GWP, START, INTAS) and (ii) an adaptation of its data and metadata management tools to make information friendly available for such integrated environmental assessments and research within a regional sustainable development perspective.

1. Sustainable environment management: a worldwide challenge still to be met.

"Think globally, act locally". That maxim of the global change scientists acting together within the four related international programmes (IGBP[1], IHDP[2], WCRP[3], and DIVERSITAS), which are initiating a new phase and setting up together the so-called ESSP[4], could be as well the flagship of the MEDIAS network activity. Global change issues are a major scientific and socio-economic concern for the whole mankind. Nevertheless, its origins and impacts are of specific concern at the regional, national and local scales, which bring the actual attention of citizens and policy makers. Addressing these issues need both a multidisciplinary and a multi-scale nested approach and information datasets, taking into account highly complex scientific research and major socio-economic challenges in a global integrated approach. Indeed, IGBP and ESSP are evolving towards Integrated Regional Studies, which is quite in line with the ideas and plans presented here (IGBP, 2002).

The **public, scientists and policy makers concern about environmental issues**

[1]International Geosphere Biosphere Programme.
[2]International Human Dimensions Programme
[3]World Climate Research Programme
[4]Earth System Science partnership.

dramatically evolved in the last decades from a large lack of awareness to the WSSD[5], Johannesburg, August–September 2002.

Several pioneering scientists and managers played a major role in bringing theses issues to public awareness step by step. The unsustainability of growing human pressure on limited natural resources was emphasised in a neo-Malthusian "sociobiologic" approach by Osborn (1949) followed by such authors as Hardin (1968, 1993), a concept strongly criticised by several scientists that developed alternative visions (Le Bras, 1994). In the sixties, some authors began to draw the attention on serious threatens faced by our environment (Dorst, 1965). In the very beginnning of the 70's, another kind of alarm was sent by the "Club of Rome" led by Sicco Mansholt in his famous report "Limits to growth". Sometimes wrongly presented as "An end to growth", that report sparked immediate controversy, but for the first time threats to the global environment became a matter of public debate. Some authors as Dansereau (1976) draw the attention on the need of interdisciplinary ecological research. Basic research works were undertaken in several environmental fields, including economic and societal aspects. Among a lot of others, at least works led in that specific domain by Constanza (1991) and by O'Connor (1994) have to be underlined.

In parallel, policy makers took the challenge into proper account, ordering reports, organising international conferences, signing multilateral environmental agreements.

In 1975, the so-called "Hammarskjöld[6] Report" presented to the 7^{th} Extraordinary General Assembly of the United Nations and entitled" What Now: Another Development" was a major formal milestone in international awareness of links between environment and socio-economic development.

In 1987, the World Commission on Environment and Development issued the so-called "Bruntland" report[7], which for the first time developed the political concept of "sustainable development" as "meeting the needs of present generations without compromising the capacity of future generations to satisfy their own."

The UN Rio Earth Summit in 1992 and the adoption of the Agenda 21 put such issues in the scientific and political forefront and gave a decisive impetus to interdisciplinary environmental research at large. It should be recalled that the UNFCCC[8] and the UNCBD[9] were adopted on that occasion. Official national and international positions and policies were elaborated or consolidated, while authoritative voices sometimes advocated alternative visions, thus nurturing the debate about sustainable development issues. For instance, J. Stiglitz, an economy Nobel Prize winner, expert of the World Bank and advisor of the former US President, openly criticised the IMF[10] policy in developing countries (Stiglitz, 2002). Earlier works by O'Connor have also to be quoted (*op. cit.*). The world-wide reactions to the present US positions about the Kyoto Protocol and in contrast the positive results of the UNFCCC COP–7[11] in 2001 (Marrakech declaration) have also to be recalled.

Dramatic advances in scientific knowledge, forecasting and monitoring tools such as data collection including space observation technology (CEOS, 2002), modelling and data assimila-

[5]United Nations' World Summit for Sustainable Development

[6]Dag Hjalmar Agne Carl Hammarskjold was Secretary-General of the United Nations from 10 April 1953 until 18 September 1961 when he met his death in a plane accident while on a peace mission in Congo. The Dag Hammarskjold Foundation was set up in 1962, and issued the cited report.

[7]M. Gro Brutland, Prime Minister of Norway, headed that Commission.

[8]United Nations Framework Convention about Climate Change

[9]United Nations Convention for Biodiversity conservation.

[10]International Monetary Fund

[11]7^{th} Conference Of Parties

tion, capacity building, telecommunications, could have helped in achieving the Rio objectives. It must nevertheless be recognised that we are far from such a situation. Since the world vowed to reduce GHGs[12], emissions of CO_2 have increased by 10% worldwide (18% in USA). Although more than 180 nations agreed to protect biodiversity, less than 40 countries have conservation measures in place. Among others, coral reefs and tropical forests continue to degrade. No improvement of the ecological situation in the Aral Sea basin can be noted. Development aid from rich countries has declined from a share of 0.35% income in the early 90's to 0.22% in 2000[13], in spite of strong needs and expectations of developing countries (Winter, 2000) supported among others by European countries.

The WSSD[14] took place in Johannesburg from August 26 to September 4, 2002. It was by far the largest UN meeting ever organised. Nevertheless, political signals delivered are quite contrasted. While Europe and most of the developing countries aggressively supported the idea of adopting a proper sustainable development agenda and pushing it at the forefront of international relationships, the President of the USA declined the invitation to attend the summit, and no such commitment was taken. The WSSD adopted a Plan of implementation focussed on the following items:

- Poverty eradication.
- Changing unsustainable patterns of consumption and production.
- Protecting and managing the natural resource base of economic and social development.
- Sustainable development in a globalizing world.
- Health and sustainable development.
- Sustainable development of small island developing States.
- Sustainable development for Africa.
- Other regional initiatives: sustainable development in Latin America and the Caribbean, in Asia and the Pacific, in the West Asia region, in the Economic Commission for Europe region.
- Means of implementation.
- Institutional framework for sustainable development: objectives; strengthening the institutional framework for sustainable development at the international level (role of the General Assembly, of the Economic and Social Council; role and function of the Commission on Sustainable Development; role of international institutions; strengthening institutional arrangements for sustainable development at the regional level and institutional frameworks for sustainable development at the national level).

The ambition of the MEDIAS network is to play a quite modest but positive role within the framework of this plan, by networking scientists, service providers and decision-makers, and providing them with friendly accessible relevant information.

[12] Greenhouse Gases
[13] Only the Netherlands and Nordic countries have fulfilled their commitements
[14] World Summit on Sustainable Development

2. Introducing the MEDIAS network, its associates and its mission.

One of the practical answers when facing the above described challenge is to set up **dedicated regional interdisciplinary scientific networks** (the "local" aspect), closely linked to major international structures and programs or structures dealing with global change issues (the "global" aspect) on one hand, to decision making structures on the other hand. The challenge is both scientific and institutional, since natural regions do not always have such relevant regional or political structures, and finding a common language bridging scientists and decision-makers is most often a difficult work. So, having federative structures appear as a relevant solution to help filling such gaps. Some of them that strongly support the MEDIAS initiative in Central Asia are briefly described below. The MEDIAS network itself can be considered as one of them.

START (The SysTem for Analysis, Research and Training) was initiated in 1990 (Bellagio, Italy) as a joint IGBP/IHDP/WCRP/DIVERSITAS structure. It provides the necessary structure of networks, centres and sites to address the regional aspects of global change. It focuses on training and capacity building, in particular to strengthen the much-needed participation of developing countries in global change research. It should play a key role in ESSP. Regional research networks are progressively established and developed in a number of regions which have been defined as a primary basis in terms of scientific needs, biogeographic features and existing regional collaborations.

Among many other initiatives, the European Commission set up the **ENRICH** programme, aiming at pursuing a major coherent European contribution to international actions on global change research. ENRICH aims first at supporting the knowledge base for the development of EU policy objectives. It intends to do so by acting as a clearinghouse for the exchange of information and by promoting co-operation in research and capacity building. ENRICH aims also to encourage the endogenous research capabilities in developing countries. It achieves its objectives through improvement of communication, collaboration and co-ordination with the aim to increase synergy and coherence, promotion of partnership and capacity building.

INTAS is an independent international association formed by the European Community, European Union's Member States and like minded countries acting to preserve and promote the valuable scientific potential of the NIS partner countries through East-West Scientific co-operation. INTAS issues calls for proposals allowing scientists from both sides to determine their own research agenda, sets up agreements for scientific cooperation, and has a network of information desks in the NIS. INTAS is open to joint initiatives with other organisations and with industry.

APN[15] is an inter-governmental network for the promotion of global change research and links between science and policy making in the Asia–Pacific Region, as are ENRICH and IAI[16]. APN promotes, encourages and supports research activities on long-term global changes in climate, ocean and terrestrial systems, and on related physical, chemical, biological and socio-economic processes. The countries in the region are carrying out many research activities in the field of global change, but much closer transnational cooperation, coordination and information exchange are needed. APN has close relationships with IGBP, IHDP, WCRP, DIVERSITAS, and cooperates closely with START, and its regional committees in the APN region

In line with **START** and **ENRICH** initiatives, a complementary idea was to develop the

[15] **A**sia–**P**acific **N**etwork for Global Change Research

[16] **I**nter–**A**merican **I**nstitute for Global Change Research

MEDIAS network concept and its federative structure, **MEDIAS–France**. This structure was created in 1994 and consolidated in 2000 as a non-profit organisation ruled by the French law[17]. Its main objective is to bring together scientists and policy makers addressing global change issues, origins and impacts at global, regional and local scales. Its main goal is to promote appropriate interdisciplinary studies that address global environmental issues from a regional perspective, and to develop first long term data and information management and observing system networks, and also training, analysis and synthesis of results, and dialogue with the socio-economic world, on a collaborative basis at regional scale (Hoepffner et al., 2000). From its very beginning, the MEDIAS initiative was encouraged and supported by START (ensuring its Regional secretariat in the Mediterranean region) and by ENRICH. When addressing the Central Asia issues, a strong support was also received from APN and INTAS.

Presently, **the MEDIAS network** brings together some 2300 scientists, service providers and policy makers and more than 1000 various organisations. At its beginning, the Mediterranean basin and subtropical Africa were the sole geographical working areas of the network. Following the consolidation in 2000, some extensions are on the way, notably to the Central Asia region and to global issues, while some specific missions were reinforced.

The objective of **MEDIAS–France** is to act as a service structure encouraging scientists and researchers to have a better dialogue, a better access to information tools and capacity building opportunities, ensure proper synergies, have their voice better heard by their own colleagues, international donors and decision makers. The **MEDIAS network** is primarily what its members want it to be, and is mainly built by their own efforts and contributions. MEDIAS-France provides services (among which setting up environmental databases and encouraging information circulation is a key issue, as explained hereunder), outreach and capacity building activities, in order to assist such a development on an equity basis. Setting up links between developed and less favoured countries is a key word for MEDIAS-France (Fellous *et al.*, 1996; Begni, 1998, 2002). The network is heavily involved in most of the issues described in Chapter 1 in line with the WSSD implementation plan, and works out several related information databases and capacity building activities.

3. Drawing the basic MEDIAS network guidelines

When consolidating MEDIAS–France in 2000, its Council and the French Ministry of Research approved the three following **major guidelines** along which actions are developed. These guidelines allow focussing the MEDIAS–France activities but are also flexible enough to face the fast changing needs of the various communities that address global change issues.

3.1. Data and information management supporting the network research activities.

That activity is the main purpose of the present paper, so it will be specifically developed here.

Encouraging networking has already be presented as the 'raison d'être' of MEDIAS–France since it is the co-ordinating unit of the MEDIAS network. As underlined above, some 2300 scientists, service providers and policy makers joined the network, as well as some 1000 institutions

[17]MEDIAS–France brings formally together seven institutions: CNES, METEO-France, IRD, CNRS/INSU, UPS, CLS, and SPOT–IMAGE. An enthusiastic tribute must be paid here to these organisations. Without their support the MEDIAS network would simply not exist.

of several kinds. Co-ordinating that structure is not an easy task. Regional and disciplinary activities have to be recognised and encouraged, while keeping MEDIAS as a coherent network. Central Asia, and namely the Aral Sea region, has been acknowledged in 2000 as a new working area of the MEDIAS network.

In the global change discipline, no scientific network can exist if experimental measured and validated data cannot be shared on a friendly basis. So, beyond setting up and co-ordinating the overall MEDIAS network or some dedicated parts of it (either regional or thematic), the prime duty of MEDIAS–France, as a service structure, is to help the network to share relevant information in compliance with commonly accepted agreements. Having information saved according to standard rules and kept accessible on the long run is also a major concern. So, software engineering in setting up large perennial databases and metadatabases and associated friendly tools has been recognised from the beginning as the key technical excellence field of MEDIAS–France. A lot of investments and efforts were dedicated to that goal. Now, MEDIAS–France is in a position to have an efficient dialogue with scientific data users worldwide and to design and implement the most suited tools (Hoepffner *et al.*, 2000). Among them, multidisciplinary federated databases and metadatabases have been recognised as a fruitful tool to fill up these objectives. Such a concept is under consideration to bring together environmental and climatic information in Central Asia, taking into account previous achievements by MEDIAS–France and already existing regional concepts and developments (Krutikov *et al*, 2001).

3.2. Overall information and dedicated capacity building

MEDIAS–France is co-ordinating international interdisciplinary scientific activities in emerging domains and disciplines that answers societal and political demand on the medium and long run and often implies short-term negotiations, decisions and actions. To achieve that goal, appropriate knowledge has to be widely and quickly spread, in various domains and at several levels.

As a consequence, MEDIAS–France has to circulate information by being active in conferences and symposia, dedicated journals, setting up websites and editing the "MEDIAS newsletter". More important, it has to act in training and capacity building activities within domains closely related to its core activities, relying on existing structures whenever possible and efficient. Such activities can be integral part of projects supported by MEDIAS–France. Dedicated actions may also be proposed. MEDIAS–France can also bring specific modules to overall capacity actions that go far beyond its domain of activity. Also, fellowships and visiting scientist programmes can and have been encouraged, either in MEDIAS–France or in other institutions of the MEDIAS network facilities.

It has been noted that the demand exceeds by far the needs, mainly but not only in the socio-economic domain. Here, the close link between START and MEDIAS–France is a key tool when leading that policy. Most of the capacity building activities in the MEDIAS network would simply not have been possible without the START support.

In Central Asia, the need of having capacity building activities in the workplan of the nascent MEDIAS regional network has been underlined by several actors, among which the LUCC IPO[18].

[18] **L**and **U**se and **C**over **C**hange — **I**nternational **P**roject **O**ffice

3.3. Scientific co-ordination and consultancy

This activity brings together several types of actions that heavily rely upon the MEDIAS network expertise and the data and information bases it set up. The key idea is to lead synthetic studies and surveys that might bring scientifically validated information to decision and policy makers in a direct or indirect way. Examples are analysing research gaps and recommending plans and agenda to fill them, defining information needs to lead national or international action plans or multilateral agreements, or answer various specific queries from national or international structures. Technological transfer to public and private service providers and industry is also an important activity that faces a strongly growing demand. Links to NGO's may be important as well. The final idea is to lead adequate people to interact with the poplulation itself: **"People are part of the solution, not part of the problem"** (Gliese, 1996)

4. The Central Asia Region and the Aral Sea Basin: Some key issues

The **climate changes** occur both under the effects of natural climate forcing factors and under the impact of the anthropogenic factors (global and local ones), their mutual interactions and coupling effects (IPCC[19], 2001). The developing countries and the countries with an economy in transition located in arid and semi-arid climate zones are especially vulnerable. Here even minor changes in the air temperature and precipitation greatly influence the water resources amount, agriculture and other human activities, human health and the whole regional ecosystem.

Such is the case of the **Aral Sea watershed**, without contest one of the regions in the world in which the environmental degradation under anthropic pressures is the most severe (Létolle *et al*, 1997, 1998, 1999, 2000; Mainguet *et al.*, 1995b, 1997, 1998a, 1998b; Dech *et al*, 1995). Abundant **water resources** flow from the Pamir Mountains and associated watersheds to Aral Sea. Amou-Darya and Syr-Daria and tributary rivers flow through mountainous valleys, arid areas, oasis and agricultural areas such as the Fergana valley. This paved the way to ambitious development decisions such as cotton intensive cultivation, implying major irrigation plans and use of chemical products (pesticides, fertilisers) that undisputedly brought short term economic development. Undisputedly too, they brought ecological disasters such as soil and water salinisation and pollution, and Aral sea level dramatic decrease, which evidences a non-sustainable strategy on the long term, a time scale at which the global climate change has to be taken into account (according to the 2001 IPCC conclusions).

In terms of **water resources shortages**, some quantitative figures can be developed. The Syr Darya River water availability significantly dropped in the past decade, imposing serious limitations on all water "users": agriculture, industry, populated areas and, of course, the Aral Sea itself. In 1995, the Syr Darya River basin had the following breakdown of water consumption: agriculture — 36.5 per cent, industry — 0.7 per cent, population — 0.5 per cent, the Aral Sea — 22 per cent, and others — 0.3 per cent. In as much as losses account for about 40 per cent, the problem of rational water use is extremely acute. The losses are determined by numerous factors, both natural (evaporation, filtration, etc.) and anthropogenic (water use for cultivation, quality of irrigation systems, etc).

[19] **I**nternational **P**anel on **C**limate **C**hange

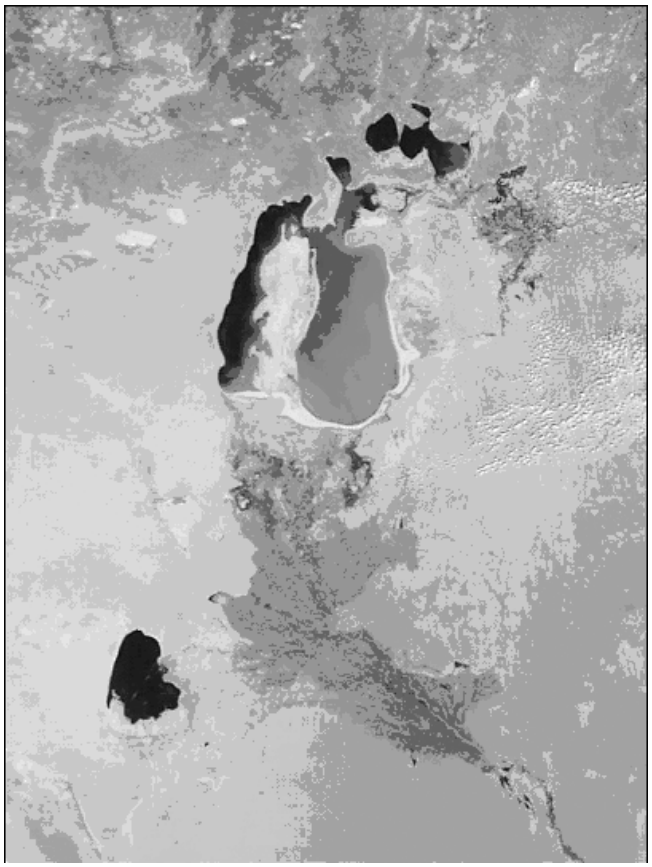

Figure 1. The Aral Sea stands out in green against the arid land of Southwest Kazakhstan and Northwest Uzbekistan in this true-colour TERRA/MODIS image (Date: August 19, 2001 — ©NASA) — When comparing to images presented in Fig.3, it can be seen that the large central island visible in fig. 3 (1998) is now linked to the continent (2001). Only a small channel links the two parts of the sea, which will be divided in two parts if the water level goes on lowering. Outstanding differnces can also be seen when comparing this image to fig.2 (1998).

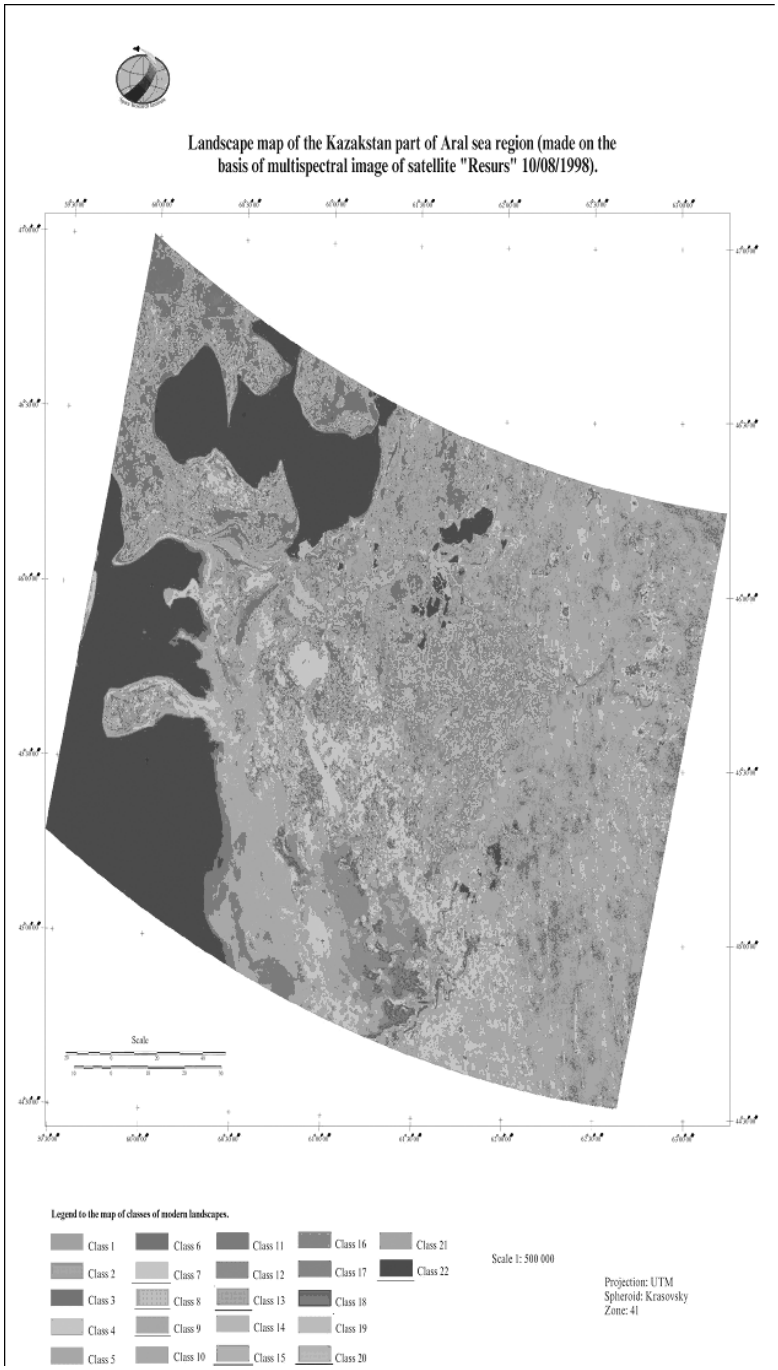

Figure 2. A land cover map of the Aral Sea derived from a RESURS-01 image. *Courtesy of Pr. E. Zakarin, SRI, Kazakhstan.*

Water deficit outside irrigated areas in arid and semi-arid climate zones generally cause **soil salinisation and desertification**. In addition, pesticides and fertilisers imports cause water and soil pollution. Land salinisation often occurs also within irrigated areas and dramatically decrease the soil fertility. This leads to abandonment of these areas, here as well as in other countries: such figures as 50% in Iraq, 30% to 40% in Egypt, 35% in Pakistan have been reported (Barrow, 1994). Nevertheless, in most countries, this situation is the result of superimposed local tends. In Central Asia, the phenomenon takes place at an unprecedented scale in terms of geographic extent and severity, due to an overall mismanagement linked to policy-making processes.

Regionally important phenomena such as **erosion, soil and dust transport** (Zakarin, 1999b, Zakarin *et al.*, 1999d — see fig. 3) have also to be taken into account. Wind erosion regional system, causing soil and dust transportation (including salt and man-made chemical substances) has a major impact on land cover. This causes for instance fertility transfers from Kyzylkoum to Karakoum as well as salt and pollutants transportation and air pollution. This also increases the atmospheric aerosols concentration, which may modify the tropospheric physics and chemistry, the radiative processes by backscatter and absorption of solar and terrestrial radiation, and change properties of rainwater and atmospheric pollution. Water cycle (snowmelt in particular) and quality (import of pollutants) may also be changed. Last but not least, this also causes serious threats to human health.

The **economical and human components** are one of main issues and the crisis is induced to the detriment of healthy environment and healthy economy. Solving or at least mitigating the crisis must, therefore, involve backfiring to the human component. This will provide a stabilising feedback that would bring about a homeostatic equilibrium, in a desirable or undesirable form. It will be necessarily dynamical, centred about some evolution trajectory driven by unaccounted-for factors (e.g., innovation). Century can be considered as a time horizon for this trajectory. The feedback mechanisms that stabilise evolution should have a characteristic time between years and tens of years. The admissible time for locking into this feedback is no more than 20–30 years.

That situation leads to two major direct influences **on human health** (Kisselev *et al,* 2000):

- through pollution of drinking water and soil by pesticides, herbicides, salt, etc.
- through inhalation of highly toxic suspended particles brought by the wind from soils and the exposed Aral seabed, as presented above.

There are three main **influences on the population sustainability** within the time frame considered:

- decreasing fertility of soil due to salinisation;
- water availability for agriculture (Kinzelbach *et al.*, 1998)
- labour availability for labour-consuming irrigated agriculture.

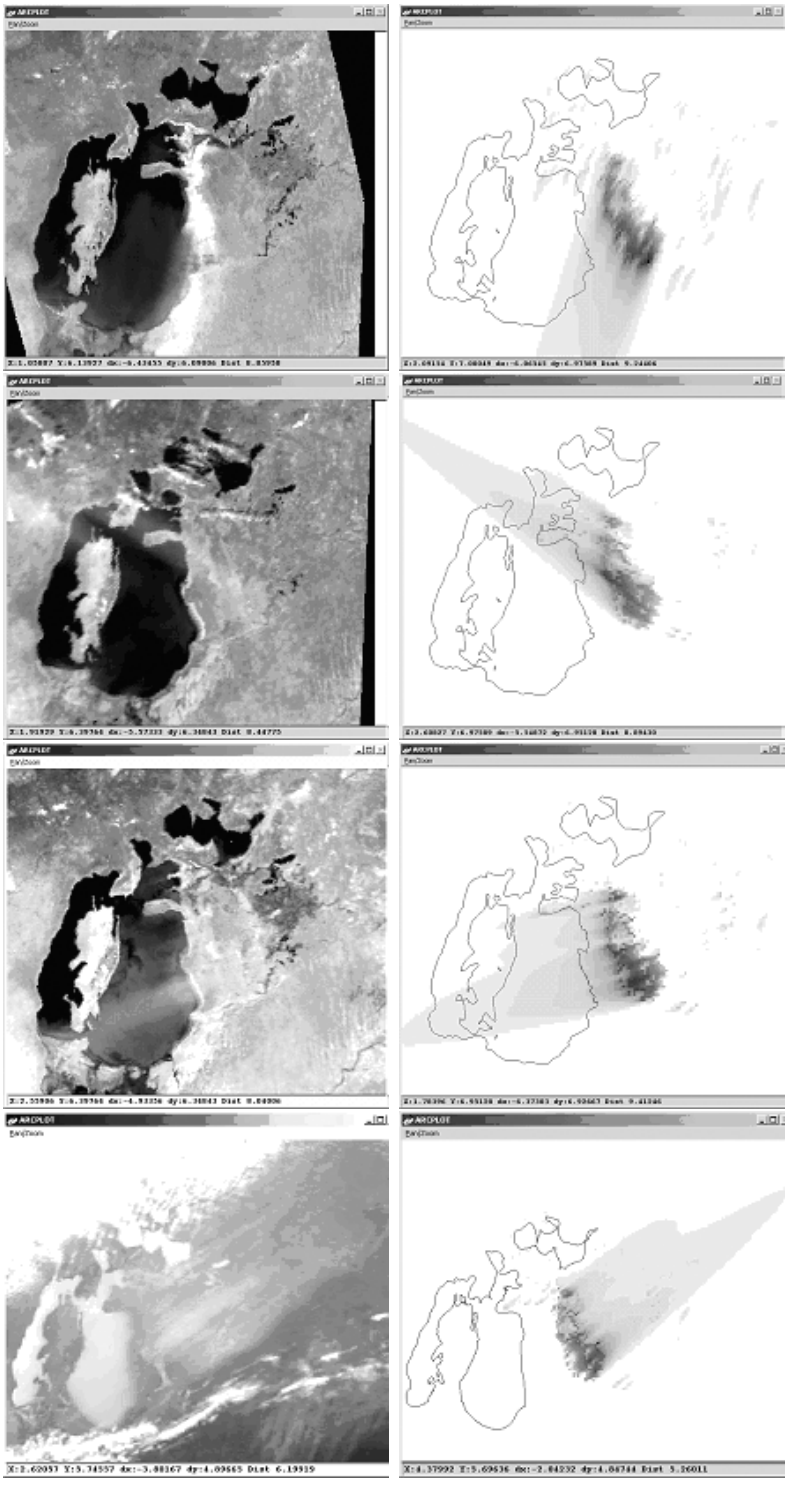

Figure 3. Comparison results of dust storm episodes simulation (right) with space monitoring data (left) — Courtesy of Pr. E. Zakarin, SRI, Kazakhstan.

5. Facing the situation: the present MEDIAS Central Asia initiative

5.1. Developing a framework for regional co-operation

In short, anthropic pressures on land use and resources led to major environmental damages in the Aral Sea basin. Some of them are certainly irreversible; others can be mitigated only through radical management practices changes (e.g. Mainguet *et al.*, 1998, 2000). Past and present economic development proves to be unsustainable. This is clearly a situation where a regional research coupling IGBP and IHDP objectives has to be undertaken (see Chapter 1).

LUCC is a joint core project of the IGBP and IHDP global change scientific international programmes. It develops and endorses regional projects and networks, working in close co-operation with START. The above-described situation shows that the Aral Sea Basin is — or should be — **a typical case study for a LUCC–oriented set of interdisciplinary studies led by a LUCC–labelled network.** But nevertheless, no such endorsed network or regional project exists so far.

Taking note of that situation, some regional, European and international scientists and institutions decided to **take some initiatives to go forward** and break that situation. Scientists from SRI (Space Research Institutes) in Kazakhstan and Russia, SANIGMI and UNDP in Uzbekistan, SCERT in Russia/Siberia, DLR/DFD and Fraunhaufer Institute in Germany, University of Reims and MEDIAS–France in France decided to join their efforts to set up the nucleus of such a network. Having it as a regional part of the overall MEDIAS network was deemed relevant.

A first result was a co-operative work for the definition of an integrative ambitious "backbone" research project.

A second step is the involvement in major regional symposiums. It included first a participation to a LUTEA meeting in Ulan-Bataar (Begni *et al.*, 2001) in June 2001 (sponsored *inter alia* by MEDIAS–France), then to the ENVIROMIS–2 symposium in Tomsk–Akhademgorodok, July 2002 (Begni *et al.*, 2002b & 2003). The CITES symposium (Tomsk–Akhademgorodok, September 2003) is a third opportunity to refine these contacts. Side meetings during these symposia allow to refine concepts and initiatives.

A third step led in parallel is the simultaneous preparation of plans for a regional workshop allowing to better define the detailed network scientific workplan and a draft proposal to LUCC to help better focussing the planned network definition. LUCC encouraged the initiative, suggesting important improvements. IN parallel, very fruitful contacts were led with the INTAS association. A representative of the nascent CA network was invited to the INTAS–CNRS–DFG Aral Sea Basin Conference, held in Bukhara, Uzbekistan, 4–8 April, 2003 — mid-term review of INTAS regional projects.

The fourth step will be the regional workshop presented above. This workshop will take place in Tashkent, Uzbekistan, January 20–22, sponsored by START, APN and MEDIAS–France. It should be a key milestone in consolidating the network and building its action plan. During these many iterations, new European and regional scientists joined (and hopefully will join) the initial network nucleus.

The ultimate goal is to consolidate the scientific LUCC network in that region, closely related to the MEDIAS network, have it formally endorsed by LUCC and START, and define

LUCC endorsed projects and their possible relation with some regional projects as LUTEA[20]. Close links with APN are very important too.

The key issue is now to consolidate the network and to push forward its "backbone" interdisciplinary research programme in order to better understand the interactions between anthropic and natural factors and favour a more sustainable development in terms of land use, economy, human health and environment protection. The interaction between water resource availability and consumption is the core issue to be addressed (see 5.2.).

5.2. Developing the network scientific workplan

As underlined above, the issues described in Chapter 4 clearly need to be scientifically addressed from an interdisciplinary point of view, in the interest of present and future generations in the region.

The first urgent issue is to have an accurate vision of what data and metadatabases are available. Data collected through remote sensing from space are available as they are in other parts of the world (see fig. 1 and 2). Regional and international know-how has been developed to use them (Dech *et al.*, 1993; Krutikov et al., 2001; Zakarin *et al.*, 1996, 1999a, 1999d, 2000). Hydrometeorological and climatic data are also available and widely used (Nikulina *et al.,* 1998, 2000). Other information is much more sparse, often in analog form, poorly archived, difficult to locate and retrieve. A huge job has to be undertaken to collect such information and archive them according to database standards. The multidisciplinary federated database and metadatabase concept developed by MEDIAS-France to fulfil the MEDIAS network needs appear quite relevant to achieve such a goal (see §3.1 and 5.3).

A series of dedicated studies and models have to be developed or consolidated to take into account the various key factors described above. Studies may provide some elements or at least some input to models; conversely, running models in proper conditions can give additional information to be analysed in studies, a first step to cross-validation. Dedicated thematic models need to be validated then nested and/or integrated to study the possible regional homeostatic equilibriums described in Chapter 4.

Some key issues among a lot of others are:

- identification of global change signal at regional scale within the natural climate variability (Planton *et al.*, 2000; Nikulina *et al*, 1998, 1999, 2000)

- water resources availability, consumption by physical and anthropic users and future resource forecast, including regional climatic aspects (Agaltseva *et al.,* 1996, 1998; Bobée *et al.,* 2000; Kinzelbach *et al.*, 1998a, Mainguet *et al.,* 2000)

- land degradation, and more especially soil salinisation and desertification due to water shortages and import of pesticides and fertilisers (Barrow, 1994; Ressl, 1996; Létolle *et al.*, 1999; Mainguet *et al.*, 1995, 1998a, 1998b)

- erosion, soil and dust transportation due to the specific regional wind regime and the soil conditions described above (Zakarin *et al.,* 1999b, 1999c, 1999d; Mainguet *et al.*)

- impacts on human health (Balter *et al.* , 2001; Begni *et al.*, 2000; Kissilev *et al.*, 2000)

[20]Land Use in Temperate East Asia, a project supported by START, LUCC and the Asia-Pacific Network for Global Change (APN).

- main socio-economic impacts and feedback at large (Bobée *et al.*, 2000; Kinzelbach *et al.*, 1998a, 1998b, 1998c; Létolle *et al.*, 1999; Mainguet *et al.,* 1995, 1997, 1998; Ressl, 1996)

- general methods and tools for overall modelling at the regional scale, including analysis of possible equilibrium's, and especially identification of the most vulnerable areas (Baler *et al.*, 2000; Fedora *et al.*, 2000; Krutikov *et al.*, 2001; Nikulina *et al.*, 1999; Lebedeva *et al.*, 1997; Penenko *et al.,* 2001a, 2001b, 2001c, 2001d; Polichtchouk, 1998; Smiatek, 1999; Planton *et al*, 2000; Dymnikov *et al.*, 2002)

When addressing such integrative issues, considering a central process around which the various items could be interfaced and integrated is often the most proper way to organise the interdisciplinary work. Since the Aral Sea basin crisis is primarily a water resources availability and management problem, that issue is considered as the central process to be addressed. This is quite coherent with the observed phenomena and the LUCC vision as a joint IGBP/IHDP initiative. Such an approach has been successfully applied to set up a LUCC network in the Meditarrnanean basin (Puigdefabregas, 2001).

So, it was decided to put the interaction between water resources availability and consumption at the core of the network workplan, or, to say better, to organise the work around these issues. This does not prevent the overall approach system and the search of equilibrium status to be undertaken. It is just a matter of defining the way how to start and to to go ahaead.

In order to give a conceptual overall framework, the following diagram was set up.

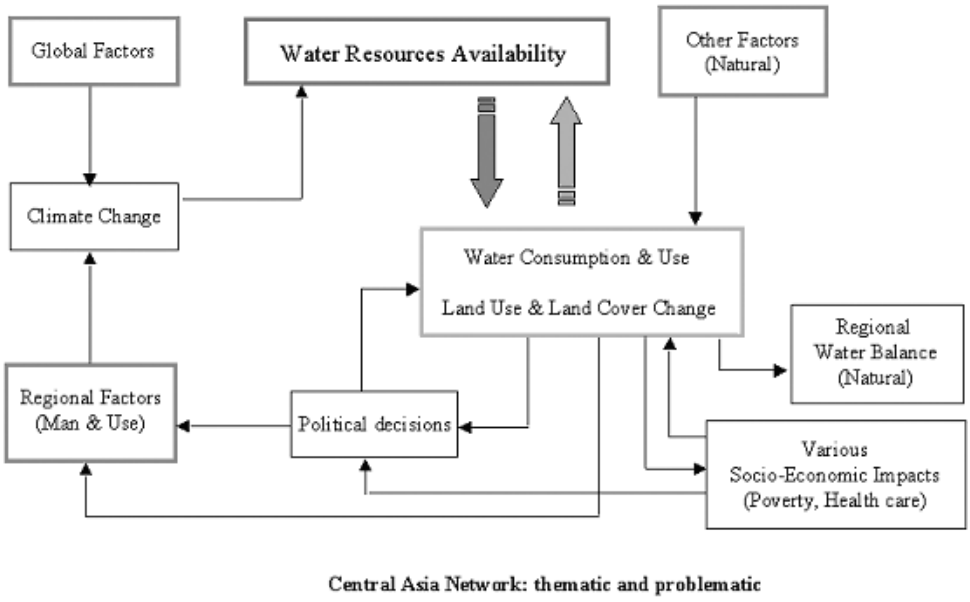

Figure 4. Proposed flowchart to structure the work of the Central Asia LUCC network.

A tentative plan has been drawn to define the outputs of the network. Links between scientists and from scientists to decision-makers are key points in the Central Asia context.

The CA Network should organise periodic regional dedicated workshops for researchers within and outside Central Asia, in order to review the state of knowledge and information available. This would allow identifying gaps and decide to implement relevant sectoral and interdisciplinary research projects. Scientifically endorsed results will pave the way to recommendations for managers in the objective of sustainable development perspectives. Dedicated workshops should also be organised for socio-economists and policy makers.

The CA Network should issue reports regrouping the research initiatives, the results of regional wide projects and the collaborative activities. These reports should first be circulated to all partners and actors for their discussion. They will be submitted for publication. On the other hand, recommendation for future research programs will also be issued. Syntheses will be circulated to policy makers.

This is an iterative process, allowing to refine the scientific knowledge, take into account monitored evolutions, build consensus on research plans and associated priorities, and periodically deliver scientifically endorsed results to various stakeholders.

This iterative process should also allow extending and consolidating the network. It should be led in close cooperation with the organisations listed above, among which START, APN, and INTAS.

Implementing such a network activity first requests a kick-off action. As described above, the network will organise in January 2004 a workshop in close connection with START and APN to better identify scientific and policy makers needs, which resources could be mobilised, draw a scientific plan and decide how to lead it. This is the proper way to take into account the recommendations made by LUCC and have the network labelled at the international scientific level.

5.3. Developing a proper data and information structure.

As quoted above, the primary mission of MEDIAS–France is to make data and information friendly available to all the members of the MEDIAS network involved in the projects they develop. Taking into account the experience gained in developing various projects, international standards and feedback, MEDIAS-France developed a generic approach that could be applied to bring together the numerous data and information bases available or to be acquired. These are most often quite heterogeneous in terms of nature, processing level, format, location, ownership rules, etc.... Nevertheless, having a friendly access to the whole set of requested information is quite mandatory to lead studies that take all relevant phenomena into proper account.

Examples of such information can be: information collected on ground about water, soils, vegetation; qualitative and quantitative socio-economic information; remotely sensed observations and derived parameters; climatic parameters. Such information can also be heterogeneous in terms of space and time scale and sampling. For instance, remote sensing allows a continuous monitoring with periodic revisit dates, ground truth information are collected at given times and places. Ground truth observations may be continuous in case of operational measuring stations, derived from periodic census or unique measurement experiments. Data may be easily available through dedicated and centralised organisations or poorly available and located in several widespread local centres. They may be free, commercial or even restricted.

The global system could be defined as follows:

Two integrated structures appear mandatory to efficiently use on a transparent basis the numerous sets of data and information:

- A set of ARAL SEA Databases (ARALSEA-DBS)
- An ARAL SEA Metadatabase (ARALSEA-MDB)

ARALSEA–DBS

Implementing the ARAL SEA databases (and existing integrated information systems) requires a federated structure. In such a concept, data are kept under the control of centres that

issue them; but are duplicated in a secured centre to archive them on the long run. Such a concept has several advantages:

- The data access policy remains under control,
- The data management is flexible and remains suited to the means of each centre,
- The workload can be fairly shared between the data producers and the federating centre,
- Such a scheme is not binding since any centre which has not proper data management systems can delegate part of the work to the federating centre.

Data queries will require a quite complex and interdisciplinary system, allowing to identify, address and download in a friendly way all information required by the network researchers. This will request from the beginning to define a small number of standards in terms of formats, geo-referencing, etc. which may justifies a specific pre-processing task. It also requests a strict co-ordination based upon a **metadata** centre, ARALSEA–MDB.

ARALSEA–MDB

The issue of ARAL SEA databases and metadata centre is to have a standard concept, mainly based upon existing experience, existing datasets, endorsed or de facto international standards. Such organisations as ISO, AFNOR, CEO, FGDC made considerable efforts to have standards allowing to efficiently implement and use metadata bases.

The following diagram presents the concept of a possible ARALSEA–DBS & ARALSEA–MDB architecture

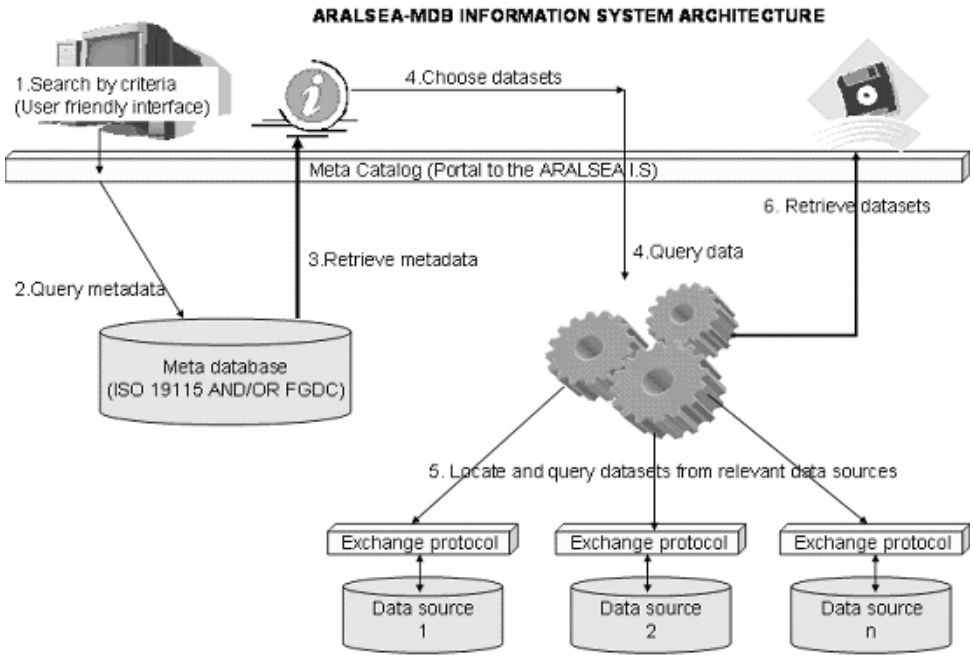

Figure 5. A conceptual scheme of ARALSEA–MDB.

Experience gained through quite different multidisciplinary projects suggests that ISO/DIS 19115 could be the most suited norm to build ARALSEA–MDB. Nevertheless, this concept is

probably too wide; a preliminary study should be led to tailor it to the actual and evolving needs of the network if necessary.

Implementing such a standard will include:

- A database that would secure integrity and follow-on of various datasets occurrences ("profiles instances")
- An XML format (DTD: Document Type Definition) that should be used as an exchange framework between data suppliers and the federating centre.

From the system point of view, two user categories have to be considered:

- The producers of data and metadata sets,
- The users that will retrieve data through a "metadata catalogue".

The first users will be served by putting in line "technical forms" available through the Web to describe the provided databases. The concepts of metadata standards, XML and metadatabases will be transparent for that kind of users.

The second category of users will be in a position to explore data through a dedicated website linked to the metacatalogue. The users' queries will be processed by the DESURVEY portal based upon the metacatalogue.

Whether it is possible to define a single standard covering all the users' needs and provided by the pre-processing service when needed or if additional modules should be developed and implemented as ancillary services in the system to help users to handle a limited set of standard cases, also supplied by the pre-processing service when needed (geographic referencing, etc. . .) has to be investigated.

This overarching information sysem may allow to create links with existing databases and information systems (for instance as described by Krutikov *et al*, 2002)

6. Conclusion: a story under vigorous development

Combating or mitigating the human and ecological tragedy of the Aral Sea basin implies a multidisciplinary dynamic system approach and a friendly access to the relevant information. A lot of excellent scientific work has already been done. Now, that work should be taken into account to go further in an integrative way. This is a work in progress. International structures such as START, APN, INTAS and LUCC are an ideal framework to build up such a process. An associated scientific network is needed, which should define a proper workplan, the related information needs and have it endorsed by these programmes.

Such a process is on the way, bringing together scientists from Kazakhstan, Uzbekistan, Russia, France and Germany. Ideas have been discussed; plans have been set up. This process needs to be consolidated both in terms of networking and workplan. A dedicated symposium will be held in January 2004 under the aegis of START, APN and MEDIAS-France. The CITES symposium is an important step in that process, allowing fruitful exchanges between regional actors sharing common scientific and human challenges.

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