

## SIMES : FINAL PROJECT REPORT

*Project Number 961620*

*Project Acronym SIMES*

*Project title Multimedia Information System for sub-saharan Environment*

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	Organisation	Role	Country
1	INRIA	C	France
2	IRD (former ORSTOM)	P	France
3	Université d'Oxford	P	United Kingdom
4	Université libre de Bruxelles	P	Belgium
5	Université de Berne	P	Switzerland
6	ERCIM	P	France
7	ESP	P	Senegal
8	Université de Dschang	P	Cameroon
9	ESI	P	Burkina-Faso
10	IER	P	Mali
11	CNTIG	P	Ivory Coast
12	IRAD	P	Cameroon

*Date 15<sup>th</sup> May 2001.*

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**A. ASSESSMENT OF WORK DONE DURING THE REPORTING PERIOD**

**Introduction**

The project objective was to bring together African and European of the IT and environment fields in a collective endeavour to find the most relevant applications of the latest IT techniques to handle typical African environmental issues. In order to reach a good level of synergy and to obtain comprehensive results, several complementary domains of IT were selected for investigation, and two representative environmental pilot operations were chosen.

The project was also organised so as to achieve a sustainable technology and know-how transfer to the African partners, particularly through the involvement of African institutions from both IT and environment background and through the recruitment and on site training of young African specialists. From the technical point of view the project was organised around an open common platform based on standard Web technologies, able to integrate the various software tools developed, and to be replicated in the two and further pilot operations, so as to gradually build up a network of compatible informations systems, offering a global approach of African environment issues, accessible through a common Web gateway.

The project started in November 1997 the 15<sup>th</sup>. The kick-off meeting was held in Dakar (Senegal) November 18-21, 1997.

In addition to the European funding, a second funding was obtained by IRD from World Bank's *InfoDev* Program, funding assigned to project WISE-DEV for K\$ 228.6. SIMES and WISE-DEV were considered as one joint project : WISE-DEV was placed under IRD's coordination and INRIA's co-coordination ; and SIMES under INRIA's coordination and IRD's co-coordination. Overall SIMES WISE-DEV was jointly coordinated by INRIA and IRD. Besides, WISE-DEV brought two new partners in the consortium : CIESIN in the United States, and CCT in Ivory Coast. Also, as indicated in the chapters below, a further funding of KFF 700 was secured, dedicated to the finally selected second pilot operation on bio-diversity.

As to the second pilot operation it should be noted that it was originally programmed in Senegal, around the Senegal river valley. In effect it has not been possible to satisfactorily develop this operation for reasons external to SIMES WISE-DEV.

Thus a change was made in the choice of this operation. The second pilot operation which was finally selected is a regional operation focused on the African bio-diversity and called "Herbaria collections computerisation and networking" : within this operation the National Herbarium of Cameroon is the leader and serves as the pilot site. The collection database and its interfaces implemented in Cameroon are to be replicated in all other partner Herbaria in the region ; the five other partner Herbaria already involved in the project are in Cameroon (two other Herbaria involved), Ivory Coast, and Senegal (two Herbaria involved). The National Herbarium of Cameroon belongs to IRAD (Institut de Recherche Agricole pour le Développement), which has since its involvement been considered as a new partner.

Thus during the second phase of the project, since the mid-term review on the 30<sup>th</sup> September 1999, the SIMES WISE-DEV consortium counted overall 14 partners.

The present document focuses specifically on SIMES Work Programme and achievements, during the second phase.

### **Tasks carried out during the second phase**

During this second phase, the following tasks have been carried out:

- Updating of the data on the fishing activities in Niger Delta (WP1)
- Selection of appropriate processing algorithms (WP2)
- Implementation of the corresponding software modules (WP2)
- Web interfacing and new modules implemented for the integrated model (WP2)
- Data acquisition, GIS and processing on Senegal river valley (WP1, 2 & 3)
- Specification & implementation of the database model for Herbaria collections (WP1)
- Specification & implementation of the interfaces for Herbaria collections (WP1)
- Data acquisition and storing of a first family of Yaounde Herbarium (WP1)
- Development of an expert system for plants identification (WP2)
- Implementation of the common software platform (WP3)
- Software tools integration in the platform (WP3)
- Implementation of the user interface for the platform (WP3)
- Integration of the software tools developed by WP2, within the platform (WP3)
- Validation of the system on the two pilot operations (WP4)
- Project management (WP6)

This list shows that the consortium's effort has logically focused on Work Packages 2, 3 and 4, except for the continuation of the surveys in the Delta and for the starting of the second pilot operation (and of course for the special package WP6, which has been ongoing throughout the project). This is in accordance with SIMES program and schedule, after the first phase which had been focused on Work Packages 1 and 5.

### **Achievements since mid-term review**

Since the last review, the following results have been achieved. In the Niger Central Delta, the surveys of the fishing activities have continued : we now have 10 bulletins produced covering 5 years of activity. It can be stated that now this monitoring system has reached a smooth, routine phase. It should be noted that for this survey system originally set up in 95, SIMES WISE-DEV added value has been to organise its computerisation, and the dissemination of its results, as well as to develop a comprehensive model linked with the survey system. Another added value has been to integrate this local mono-thematic project within a regional, multi-thematic approach.

We also have analysed the aerial images of the Niger Delta acquired during the first phase, and we have chosen among the various processing techniques that had been identified by the state of the art survey. The selected algorithms have been implemented and the corresponding software modules have been integrated into the generic platform.

The integrated model of the Niger Delta has received several improvements including the addition of some new modules, and it has been interfaced so as to be accessible on the Web from the same entry as the fishing activities monitoring system. Software links between the monitoring system and the model have been designed so as to allow some validation of the model by observed data.

In spite of the difficulties encountered with the application in Senegal, some data have been collected and organised within a GIS ; also some processing work has been done on these data.

The second pilot operation which was finally selected covers Western and Central Africa and is focused on plants bio-diversity. This operation consists in the computerisation of the Herbaria collections and in the networking of these Herbaria via a Web gateway. The Herbaria partners of the project all use the same database architecture and interface tools, and the gateway can be mirrored on each site : we thus build a distributed information system, based on autonomous databases. The operation started at the beginning of last year, with a pilot site in Yaounde Herbarium ; this Herbarium is also the leader of this operation. Four other Herbaria of the region are already partners in this operation : two in Cameroon, two in Senegal, and one in Ivory Coast. This operation has already contributed to deliverables D6, D16, and D17.

Within this operation, we have also developed an expert system for plants identification, using a specific language designed by the CSIRO in Australia. This work enters into Work Package 2.

The generic platform and its user interface have been established and results from the two pilot operations were integrated within the platform and demonstrated using its user interface during the final review on Feb 2<sup>nd</sup>.

Overall, the management and task coordination of a collaborative project associating 14<sup>1</sup> partners from three different continents, and involving disciplines from such distant fields as computer science and environment, have been somewhat cumbersome, but reasonable effectiveness has been reached thanks to the high motivation of all partners. Also the numerous IRD offices established for decades in the African countries involved in SIMES have been very helpful. It can be assessed that a very interesting synergy has been achieved, between African and Northern partners, as well as between IT and environment specialists.

Original ideas have emerged as to the use of modern IT techniques for environment applications, and a sustainable know-how transfer has been realised towards African institutions. This sustainable transfer was made possible thanks to the involvement of African partners from both IT and environment fields, which should be able in the near future to continue their initiated collaboration : particularly, the IT specialists are now in a good position to bring an efficient local support to the environment experts in the maintenance and evolution of the tools and platform developed by SIMES and already used within the two

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<sup>1</sup> Including the two partners brought in by WISE-DEV : CIESIN (U.S.A.) and CCT (Ivory Coast)

pilot applications ; they also should be able to bring a similar local support to other institutions or environment programs willing to exploit SIMES technology and methodology.

## B. CURRENT PROJECT STATUS

<i>As at end of reporting date</i>	<i>Number</i>	<i>Comments, problems with deadlines</i>
Work packages on/before schedule	WP5	Final report (D10) accepted as at mid-term review.
Work packages delayed but now completed	WP1, WP2, WP3, WP4	Some tasks have been extended to 14 <sup>th</sup> May 2001. The last deliverables will be available by 31 <sup>st</sup> May 2001.
Management task extends to 31 <sup>th</sup> May	WP6	For Deliverables D19 and D20, which will be completed during a mission in Yaoundé.
Deliverables submitted since the mid-term review	D11 to D25	
Deliverables accepted by DG INFSO	D1 to D11, D14, D16 to D18, D24, D25	Available on SIMES WISE-DEV's Web site : <a href="http://www.ercim.org/simes">http://www.ercim.org/simes</a> (in PDF and/or Doc format ; some are compressed with Winzip ; click on "Results" to access the list and download the documents)
Deliverables yet to be evaluated	D12, D13, D15, D19 to D23	D12, D13 and D15 already available on SIMES WISE-DEV's Web site ; D21 to D23 available on May 21 <sup>st</sup> ; D19 and D20 available on May 31 <sup>st</sup> .

## C. SUMMARY OF WORK DONE

Are project objectives being met?	Yes	Despite the delay of the European advance payment, project objectives are reached.
Is work done within the project budget?	Yes	The involvement of the coordinators and the institutes in charge to help for the technical, financial and administrative coordination task has been more substantial than foreseen.
Major achievements within reporting period	<p>The information system for the pilot operation "Delta Central du Niger" (available on <a href="http://www.ier.ml/peche/">http://www.ier.ml/peche/</a> ).</p> <p>The information system for the pilot operation "Cameroon National Herbarium" (available on <a href="http://www.orleans.ird.fr/~chevillo/letouze/letouzey.html">http://www.orleans.ird.fr/~chevillo/letouze/letouzey.html</a> ).</p> <p>The image processing tools developed in Senegal, applied on aerial images from "Delta Central du Niger" (available on <a href="http://www.simes.sn">http://www.simes.sn</a> ).</p> <p>The multilayer integrated model of the "Delta Central du Niger" socio-ecosystem, demonstrated in Brussels on Sept. 30<sup>th</sup> 1999 and Feb. 2<sup>nd</sup> 2001.</p> <p>The generic platform demonstrated in Brussels on Feb 2<sup>nd</sup> 2001.</p>	
Details of expected end-products Name	Software SIMES WISE-DEV	Software generic platform, and two pilot information systems, with image processing tools and a multilayer integrated model.

Project Manager      Olivier Monga      Signed

Date: May 15<sup>th</sup>, 2001

## **Part A. Synopsis of Work Undertaken**

### **A.1. OBJECTIVES AND CONTEXT OF THE PROJECT**

The project objectives were :

- To bring in African partners on applied computer science research activities around the development of observatories of the dynamics and management of renewable resources. The intrinsic heterogeneity of data in this field, as well as the specificity of their modes and rhythms of acquisition, processing and diffusion, imply the adaptation and integration of numerous tools. It seems essential that the concerned countries be party to this work.
- To give these observatories an opportunity of using the last developments in computer science for storing and processing multimedia information.
- To use the capabilities of computers and networks to give African researchers an easy access to northern technologies and information, to encourage interdisciplinary and international co-operation, and to organise the transfer from research to development by making the research results operational and accessible to decision makers.

It should be reminded that SIMES was initially proposed and approved within European Commission's INCO-DC programme. Following INCO-DC's directives, SIMES was designed as a means to develop a synergy among European and African scientists, and between the fields of IT and Environment. The aim was to contribute in providing innovative solutions for the monitoring and management of environment in sub-saharan Africa, and to develop the capacities of African institutions by training young African specialists within these institutions, to use the latest IT techniques on African environment problems.

It should be noted that so far, the opportunities for African IT scientists to work on concrete African problems have been very rare. Also in most projects of this scale, African students carry out most of their training in Europe or in the States, and often stay there, which has a low or even negative impact on the development of local capacities.

In order to fulfil these overall objectives, the project was organised around the production of a generic platform which can incorporate all the facilities to acquire, manage, process and disseminate environment data in all the relevant forms available. This generic platform can be used by the teams in charge of environment applications in order to set up their own information systems ; these systems have the capacity to be interconnected in a Web network that should allow a global approach of environment problems, on a regional scale and with multiple thematic entries.

The activities have been organised so that young African students be recruited within local institutions and be trained to use modern IT techniques in typical environment applications. The work program was focused around two main pilot operations : one in Mali dealing with fishing activities in the Central Delta of the Niger river ; and the second one covering Western

and Central Africa and dealing with the computerisation of the Herbaria collections and the networking of the Herbaria, with the pilot site and the leadership in Cameroon.

The specific objectives for the second half of the project were :

- Selection, implementation and test of the software processing tools
- Implementation of the common software base and of the user interface
- Integration of the data acquisition and processing tools within the platform
- Implementation of the information systems for the two pilot operations
- Validation of SIMES technology and methodology on the two pilot applications

These objectives were reached and the results demonstrated during the final review. The two pilot information systems, as well as specific processing tools and some Senegal data, can be accessed respectively at :

- <http://www.ier.ml/peche/> (Fishing observatory in the Niger river Central Delta)
- <http://www.orleans.ird.fr/~chevillo/letouze/letouzey.html> (Cameroon Nat. Herbarium<sup>2</sup>)
- <http://www.simes.sn> (On line image processing tools and image mosaicing results, as well as preliminary Senegal river data)

## **A.2. WORK DONE**

As indicated in the previous chapter, Work Packages related to this period are mainly WP2, WP3, WP4 (and of course WP6), with some activities related to WP1 and the starting of the newly selected second pilot operation with a focus in Cameroon National Herbarium.

A synthesis of the work done within each Work Package is presented here-below :

### **WP1 : Data acquisition, storing and pre-processing**

WP1's first objective during the twelve first months was to establish a corpus of data characteristic of the socio-environmental problematics (eco-systems, renewable resources exploitation, environmental impact of human activities), and a set of relevant indicators to be elaborated from these data. The second objective was to propose a consultation interface prototype for the future information systems, in order to enable potential users to react to this interface proposition, so as to lead the generic tools development by the demand. The third objective was to identify a list of algorithms potentially useful for the data pre-processing.

The realisation of the tasks within WP1 was guided by two pilot operations. It must be reminded that for these pilot operations, the project is dependent upon observatories which exist independently from it, and within which SIMES is in charge, partially or totally, only of the information system aspects.

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<sup>2</sup> The Internet connection of the Herbarium having not yet been established, the address indicated is that of the mirror site set up in IRD's laboratory in Orléans.



The pilot operation "Observatory of the fishing activities in Mali" perfectly played its part as source of data and processing problematics. WP1 routine operations have continued during the second phase, as can be expected of an observatory.

The second area of activity conducted under WP1 during the second phase concerns the computerisation of Cameroon's National Herbarium collection of plant specimens. The major achievements in this matter are the design and implementation of the collection database conceptual model, the computerisation of a first plant family (the Caesalpiniaceae, or "legumes", chosen for its botanical interest, its diversity, and its importance in terms of various usages).

The tasks within WP1 have been coordinated by IRD, which has also largely contributed to the deliverables elaboration, in collaboration with IRAD, IER, and ESP, and in relation with INRIA. The concrete outcome of this work during the second phase is the addition of the new data and bulletins on the fishing observatory's Web site, as well as the production of a complement to deliverable D6 relative to the Herbaria collections.

## **WP2 : Data processing and indicators display**

WP2's objective was to select and implement relevant tools to process the data collected within WP1. The concrete outcome for the second phase is as follows :

### *- Integrated Model*

A multi-layer integrated model representing the different components of the Inner Delta of the Niger (ie. topology, hydrology, biomass evolution, fishing and agricultural activities) has been developed during the first phase. Its goal is to facilitate negotiations between the various actors (fishermen and farmers representatives, technical and administrative authorities) by displaying the quantitative impact of events, activities and regulations on the overall production of the Delta area.

During the second phase this model has received several improvements, particularly to the hydrology and the agricultural layer, and it has been added a cattle breeding layer. It also has been interfaced onto the Web through a comprehensive Java applet. It can thus now be accessed and run from the fishing observatory Web site, providing the preliminary installation of a Java plug-in, which can be downloaded from the same Web site.

### *- Aerial images*

Within WP1, 50 images of the Niger Inner Delta were acquired from IGN (Institut Géographique National). These result from the only aerial image acquisition campaigns by IGN in the area. Also 5 SPOT images of the Senegal river were acquired.

These images were made available to all partners of the Consortium on an image server as well as on CD-Roms. Comments by scientific experts of the relevant disciplines on the information relevant for the pilot operations have been included.

### *- Computer vision algorithms*

The following algorithms have been tested :

- Basic tools (INRIMAGE)
- Image mosaiquing and registration algorithms  
(results available on <http://www.simes.sn> )
- Fine networks extraction

The algorithms assessed as the most interesting for the pilot operations have been implemented and the relative software tools are accessible on <http://www.simes.sn> . These results are described in D11, D12 and D13.

Deliverable D11 (“Modelling”) which partly deals with image processing has been accepted ; the final versions of deliverables D12 (“Parameters extraction”) and D13 (“Registration of spatialised data”) are available on SIMES Web site and under evaluation (draft versions of D12 and 13 had been delivered before the final review and were assessed as needing some improvement).

### *- Computer assisted plant identification*

An expert system has been developed for the first plant family (the Caesalpiniaceae) dealt with by the second pilot operation. This system is based on a standardised description of the plants main characters established using the specific language Delta ; these descriptions are used by a specific engine called Intkey (for Interactive key). Delta and Intkey have been developed by the Australian main research institution : CSIRO. The expert system has been developed in collaboration between the consortium and CSIRO. It allows to identify a plant down to the genera level, within the Caesalpiniaceae family. It is accessible from the Cameroon National Herbarium Web site (actually a mirror in IRD premises in Orléans : <http://www.orleans.ird.fr/~chevillo/letouze/letouzey.html> , since the funding currently available has not yet allowed to connect the Herbarium to the Internet). This expert system can be run from any Web browser, providing the preliminary installation of Intkey (which can be downloaded from the same Web site and then used as a plug-in within the browser).

The system will be extended to other plant families, as these will be taken into account in the Herbaria databases.

## **WP3 : Tools integration within a friendly generic system**

The objectives of WP3 are to specify and set up the system architecture and the software platform needed (task 3.1) as well as to establish the software components integration procedures (task 3.2 and 3.3).

A important effort has been required to find and evaluate tools available at a reasonable price affordable by the consortium. Another part of the effort has been to realise the taking over of these tools by the African partners.

The defined architecture aims at allowing the user to easily access all services available on a SIMES network from any Internet connected machine, as well as preserving the autonomy of the sites providing data and/or processing algorithms.

More precisely, the architecture is thought in terms of components, some of them being designed to be generic and easily integrated on the platform.

The kernel of the architecture is the concept of software bus built in three layers : an application layer, a client layer unifying the user interface and a third layer integrating all services supporting the applications. Designed to be distributed on an internet like network the system profits from the experience acquired within other ambitious projects such as PCIS2<sup>3</sup>. It was decided :

- to rely as far as possible on accepted and emerging standards : HTML for describing all exchanges with users, ODBC and SQL for database interfaces, CORBA for distribution,
- to use free software as far as possible,
- in other cases, to buy widely used commercial off the shelf tools,
- to develop new functionalities when unavoidable and to use Java, Java scripts and/or CGI for that purpose.

For the proposed system, the perspectives mainly concern information extraction, data integration, tools integration and heterogeneity management : data type conversion, meta-data definition, traders, etc..

Another direction of effort has been identified and worked on : integration of the user interface services. Here the objectives are to support the end-user navigation and information search either through traditional hypertexts and/or through geographical maps, and/or also through both simultaneously.

The main activities consisted in :

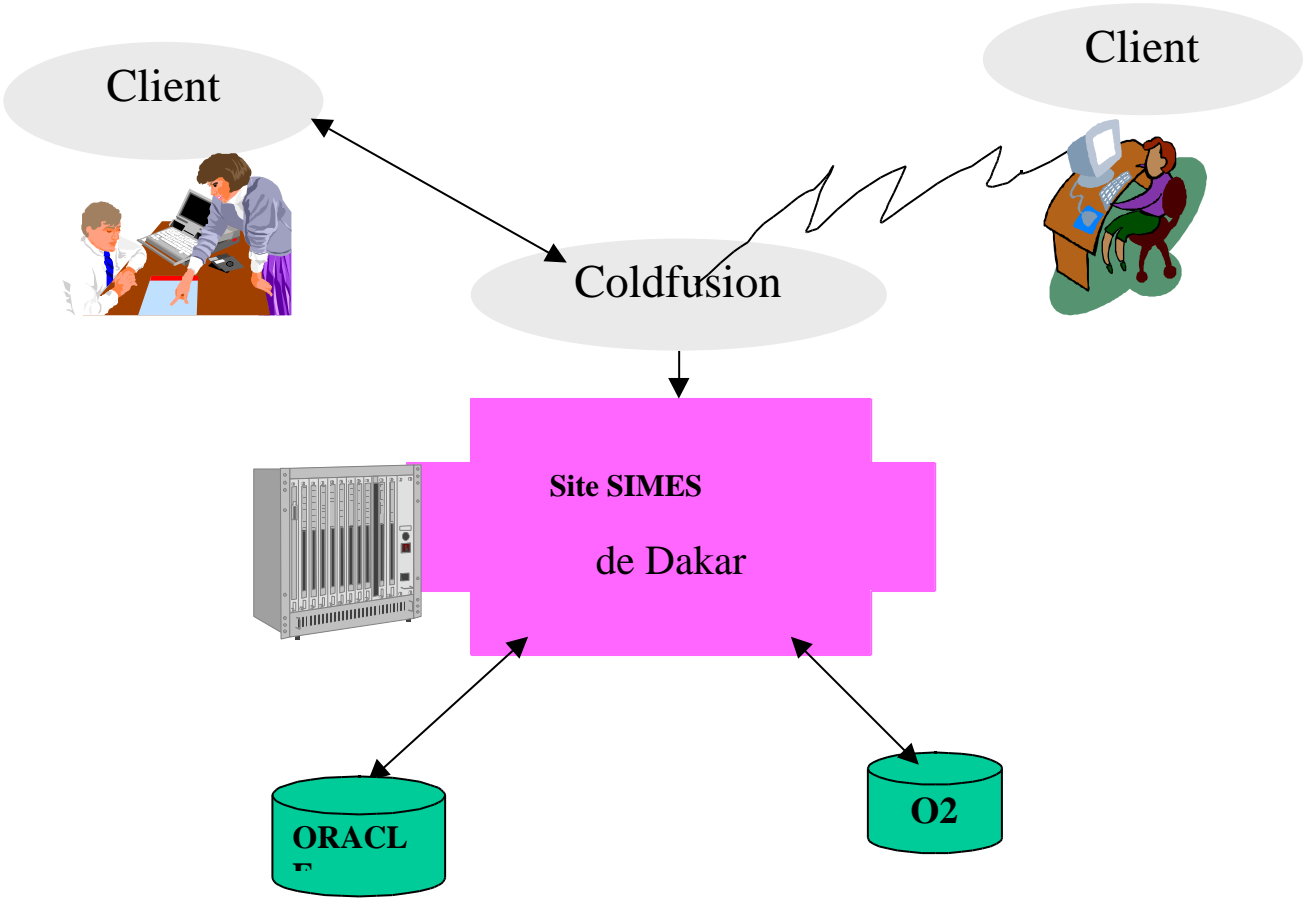
- The development of the architecture design, jointly by Dschang University and INRIA Lorraine, with contributions by other partners.
- The selection of the processing tools developed by INRIA and other partners, to be integrated within the platform.

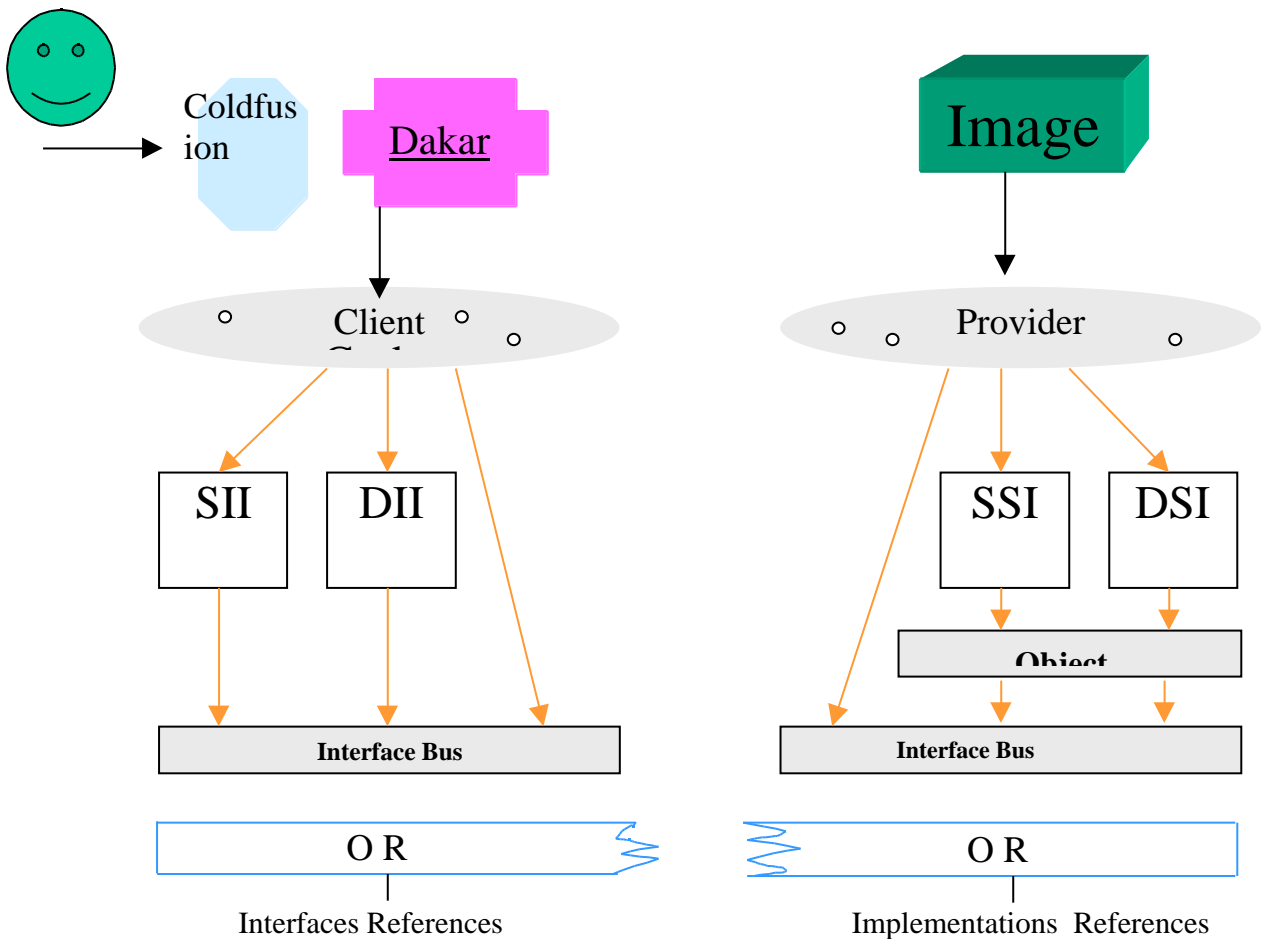
The results can be summed up in the following schemas.

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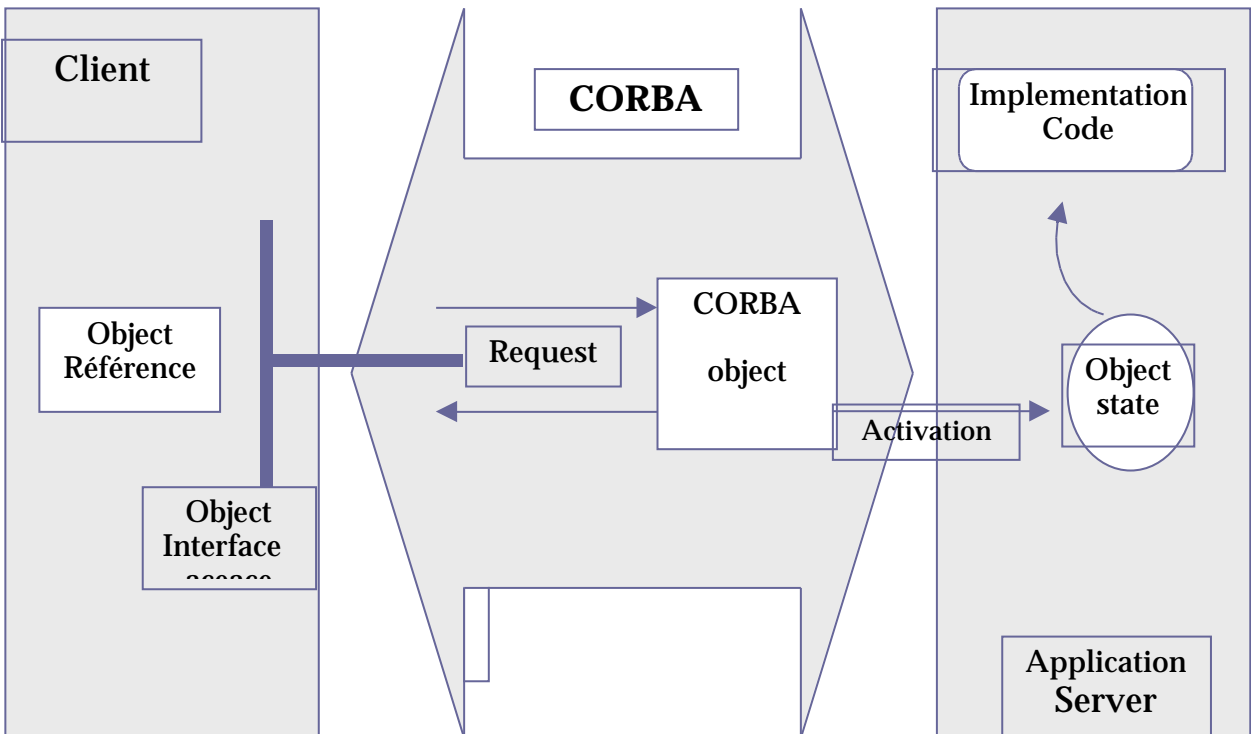
<sup>3</sup> Portable Common Tools environment : common project between US Navy and french MOD in charge of defining a platform to support secure software engineering environments on Internet. Loria has been responsible of the architecture specification . The system is currently under development by Sema group.

**Local or distant Access to a SIMES site  
from a work station to query a data base or to  
run a tool on the same site**





**The Corba architecture**



## Cold Fusion

This software provides an interface between a set of WEB pages on a WEB server and a data base ( SQL or ODBC compliant ). Cold Fusion follows a Client-Server<sup>4</sup> approach .

The main part of the software is on the server side and in the application development environment on the client side are only forms to fill out for querying , using a usual web browser.

Its fonctionnalies and advantages :

- Easy development of a set of web pages allowing a database management.
- Makes a site dynamic in its presentation as well as in its processes through the ability to create animations, with JavaScripts .
- Data base independence .
- Server management with the usual browsers.
- Convivial Interface : all commands are accessible through toolbars.
- Complete programming language.
- Support connection to systems using Corba , C/C++, VBScript, JavaScript , Java.

WP3 results were demonstrated in Brussels during the advanced final review.

## **WP4 : Implementation of operational systems for the two pilot operations**

### Observatory of the fishing activities in the Niger river Central Delta

The operational system developed within SIMES WISE-DEV is accessible at <http://www.ier.ml/peche> . It contains a comprehensive set of information relative to the Delta, its population and the fishing activities, accessible in various formats (synthetic bulletins relative to four main thematic domains, maps, various graphics, texts, etc.) ; the navigation is organised around an explicit site plan, information categories, and several clickable maps. The processing tools applied to the aerial images and their results are accessible at <http://www.simes.sn> . The data acquisition tools, used locally by IER, are installed on IER computers, and described in detail in deliverable D16.

### Herbaria collections computerisation and networking

The pilot site, Cameroon's National Herbarium, has been equipped with SIMES WISE-DEV's tools. A mirror of the Web site is supported in IRD premises in Orléans. The operational system is accessible at <http://www.orleans.ird.fr/~chevillo/letouze/letouzey.html> . This Web site presents a prototype of the gateway which will give access to the distributed information system on plants biodiversity under development beyond SIMES WISE-DEV

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<sup>4</sup> **Client** : Application program interfacing the user and the application kernel . It takes into account the formalisms used on the user support machine and available software on this machine

**Server** : Program providing services for an application making abstraction of description formalisms, usage software and support machines.

around several Herbaria collections. Six Herbaria are already partners in this development : three in Cameroon, two in Senegal and one in Ivory Coast.

The gateway gives access to a comprehensive set of query types to the collections databases (mainly access by plant scientific name, by habitat, by toponymy, and by botanist –botanists involved in specimens collections or determination- ; access by plant familiar/commercial/vernacular name, or by plant usage are under development). It also gives access to the expert system for computer assisted plants identification.

### **WP5 : Workshop about the Information Society in Africa**

This is a reminder, included in the present final report with the purpose of facilitating the project evaluation, of the activities and results of WP5, conducted and achieved during the first phase of SIMES WISE-DEV.

This work package, incorporated within the project at the request of the European Commission, aimed at studying the stakes for the African countries of their participation in the information society. The choice of SIMES WISE-DEV, as support project to this study, is motivated by the presence of the key actors in French speaking sub-saharan Africa (Burkina-Faso, Cameroon, Ivory Coast, Mali and Senegal) who have already participated in operations or studies in this sector of activity.

The first meeting of WP5 took place during the project kick off meeting. It involved additional partners beyond the Consortium (Faculté des sciences de Mauritanie, CEA, INSP, IAI). The study focused on French speaking sub-saharan Africa, the Maghreb being considered as separate and already covered by a European program dedicated to Mediterranean countries.

The situation in Europe, in the USA, in eastern European countries and around the Mediterranean sea has been described, the African particularities have been detailed.

The report plan is as follows :

- Definition of the socio-economic context
- State of the telecommunications
- Sectors of application
- Conclusion and recommendations

Collection of information has been organised to be used as a support for the report elaboration.

The specific WP5 workshop was held in Abidjan, organised by CNTIG and ERCIM. The information provided by the project partners, as well as by representatives of other African countries, were discussed and thematic briefs produced on the openings of ITCs in Africa.

A first version of the report written by ERCIM was discussed during a plenary meeting in Yaoundé and completed during the next plenary meeting in Bobo-Dioulasso. The final report has been completed and delivered in October 1999.

The draft WP5 report has been passed on to the DG XII and DG VIII and it could lead to a new approach of the European policy towards developing countries. In particular it has been used in a working group convened by the DG VIII on new technologies and developing countries.

## **WP 6 : Management**

WP6 is concerned by the overall management of the project. It is jointly conducted by IRD, INRIA, and ERCIM. INRIA, in coordination with IRD, is particularly in charge of the computer science aspects ; IRD, in coordination with INRIA, is particularly in charge of the applicative aspects ; ERCIM is in charge of the administrative, legal and financial aspects relative to the European funding.

The first objective of WP6 was to organise the work between the partners, to set up and manage the administrative and financial structure, to ensure the project progress as scheduled, and to help the partners solve the difficulties which could arise.

The second objective was to prepare for the dissemination and long term exploitation of the project results.

INRIA received the funding from the European Commission (Keuro 550) and forwarded its share to each partner.

IRD established with the *InfoDev* the Grant Agreement WISE-DEV, which brings to the project K\$ 228, in addition to the European grant, as well as two new partners : CCT (Centre de Cartographie et de Télédétection) in Ivory Coast and CIESIN in the USA. IRD also established subcontracts with the African, European and American partners, and set up at the request of the African partners specific accounts handled for them by the accountants of its subsidiaries in Africa. IRD then received the disbursements from the World Bank (the first one in February 98) and forwarded their shares to the WISE-DEV partners.

INRIA and IRD jointly organised 5 plenary meetings (Dakar, Abidjan, Bamako, Yaounde and Bobo-Dioulasso), as well as around thirty technical meetings.

INRIA and IRD have undertaken dissemination actions aiming at promoting the project, at establishing links with other projects dealing with environmental information, and at identifying future pilot operations :

- April 27<sup>th</sup> 2001 in Brussels : participation in a “workshop on intelligent systems for environmental applications”, organised by the European Commission DG INFSO on future needs in NTIC R&D for environment applications, in preparation for FP6 (2202-2206). The need for rigorous shared nomenclatures (or meta-data) was stressed, as well as the need for ergonomic gateways allowing a global approach of environment issues by accessing networked autonomous databases with direct distributed queries and on line processing tools. The idea of an “umbrella project” structured like SIMES : i.e. associating several environmental applications (pilot operations) and several technical development operations (each exploring the possibilities offered by emerging techniques



in a different technical domain), was proposed by IRD and included in the conclusions of the workshop.

- March 2001 in Yaounde : within the annual REIMP workshop, presentation by Cameroon National Herbarium of the results of the second pilot operation.
- February 2<sup>nd</sup> 2001 in Brussels : advanced final review of SIMES by the project officer and three external evaluators ; participation of four people from IRD and INRIA and four from African partners (ESP, CNTIG, Univ. Dschang). At this occasion, CNTIG proposed a future third pilot operation on the critical issue of efficiently monitoring the deforestation in Ivory Coast ; issue for which the classical tools used so far by CNTIG appear as not appropriate, whilst the first tests with the techniques developed within SIMES seem promising.
- September 2000 in Yaounde : technical mission in the Herbarium and presentation of the operation to several authorities ; submission of a small technical proposal to the French Cooperation for the funding of computing equipment in the Herbarium (KFF 60 obtained).
- April 2000 in Bamako : presentation and demonstration of the results of the first pilot operation in Mopti to researchers and technical staff involved in the monitoring of fishing activities in Niger Central Delta. Participation of *InfoDev*'s project officer for WISE-DEV.
- April 2000 in Dakar and Abidjan : presentation of the second pilot operation to Herbaria in Dakar and Abidjan, which are now partners in this operation.
- November 1999 in Libreville : presentation of SIMES and of the proposed second pilot operation on biodiversity, at the occasion of the annual workshop organised by REIMP.
- November 1999 in Paris : submission of a proposal to the FFI<sup>5</sup> requesting a complementary funding for the second pilot operation (KFF 640 obtained).
- October 1999 in Yaounde : presentation by IRD of the proposed second pilot operation on plants biodiversity to ENSP<sup>6</sup> and Cameroon National Herbarium. This was the founding meeting for the second pilot operation.
- July 21-24<sup>th</sup>, 1999 in Bamako : demonstration of the information system prototype and of the integrated model for the Malian pilot operation, during a study trip organised in the Niger Central Delta gathering around sixty researchers and engineers from Malian scientific and technical institutions ;
- June 7-11<sup>th</sup>, 1999 in Washington and New-York : presentation of the project progress to *InfoDev*, as well as to staff of several country directions, to the management staff of REIMP (Regional Environment Information Management Programme) and to UNITAR representative in New-York.
- May 11<sup>th</sup>, 1999 in Brussels : presentation of the project during a seminar organised by the European Commission on ITCs for environment.
- April 29<sup>th</sup>, 1999 in Abidjan : presentation of the project to the World Bank representation in Ivory Coast, and exchanges about the potential issues for a forthcoming pilot operation in Ivory Coast.
- July 1998 : presentation of the project during a seminar organised by *InfoDev* in Rio de Janeiro on ITCs for environment.
- March 16-20<sup>th</sup> 1998 in Washington : presentation of the project to WRI (World Research Institut), as well as to the World Bank : *InfoDev*, Department "Environnement Afrique" (AFTES), and several country directions (Mali, Burkina, Senegal, Ivory Coast).

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<sup>5</sup> FFI : Fonds Francophone pour les Inforoutes

<sup>6</sup> Ecole Nationale Supérieure Polytechnique de Yaoundé

- February to September 1998 : preparation, with FAO, of a proposal for a pilot operation on continental fisheries in Burkina Faso, transposed from the fishing observatory in Mali ; the proposal has been submitted by the Fisheries Authority of Burkina Faso to the World Bank.
- October 1997 : presentation of the project within the workshop organised by the World Bank in Bata (Equatorial Guinea) for REIMP.

### **Training within African institutions**

A specific, and most important aspect of what SIMES WISE-DEV has achieved is relative to capacity building. SIMES WISE-DEV has conducted a policy of on site local capacity development, where all partner institutions have recruited and trained University or Engineering School students. The results of this policy can be summarised as follows :

- 15 African students recruited and trained in 5 countries
- 3 theses completed in 2001 (2 in Cameroon, 1 in Mali)
- 7 Maîtrise degrees (4 in Cameroon, 3 in Ivory Coast)
- 1 Master degree in Mali
- 1 Master degree in Burkina Faso
- 3 Engineers training sessions in Senegal
- 1 One week Workshop with all the students, covering most SIMES WISE-DEV technical issues

### **Demonstrations**

The demonstrations made during the final review covered the following subjects :

- Generic Platform architecture and implementation (Jean-Claude Derniame, INRIA)
- First pilot operation :
  - Monitoring system of Niger Delta fishing activities (Pierre Morand, IRD)
  - Processing techniques selected (Tidiane Seck, ESP)
  - Integrated model (Elisabeth Benga, ESP)
- Work done on the Senegal river valley (Tidiane Seck, ESP)
- Second pilot operation :
  - Cameroon National Herbarium Database (Gaston Achoundong, IRAD)
  - Expert system for plants identification (Gaston Achoundong, IRAD)
  - Platform and user interface (Georges-Edouard Kouamou, U. Dschang)

### **A.3. PROBLEMS ENCOUNTERED**

The training of the African partners to the rules of European Commission projects, and the solving of many financial and administrative problems encountered, needed, until the end of the project, a high involvement of the coordination team.

On the technical side, the communication facilities (internet, fax) of the African partners have globally appeared less effective than foreseen during the project writing. However the situation differs largely between the countries involved. Senegal is particularly well fitted in terms of Internet connections : in Dakar the conditions are close to those in Europe ; in Mali and Burkina Faso the conditions are far more difficult, especially with the partners being located outside the capital, respectively in Mopti and in Bobo-Dioulasso ; in Abidjan, CNTIG and CCT have similar difficulties, in spite of being located in the capital ; the worst conditions were encountered in Cameroon, where Yaounde, although being the administrative and political capital, has rather poor Internet facilities ; the particular situation of Dschang University (about 250 km from Yaounde) was even worse. Globally, the coordination team had to make a particular effort to overcome the difficulties created by the poor level of the communication facilities available for the African partners.

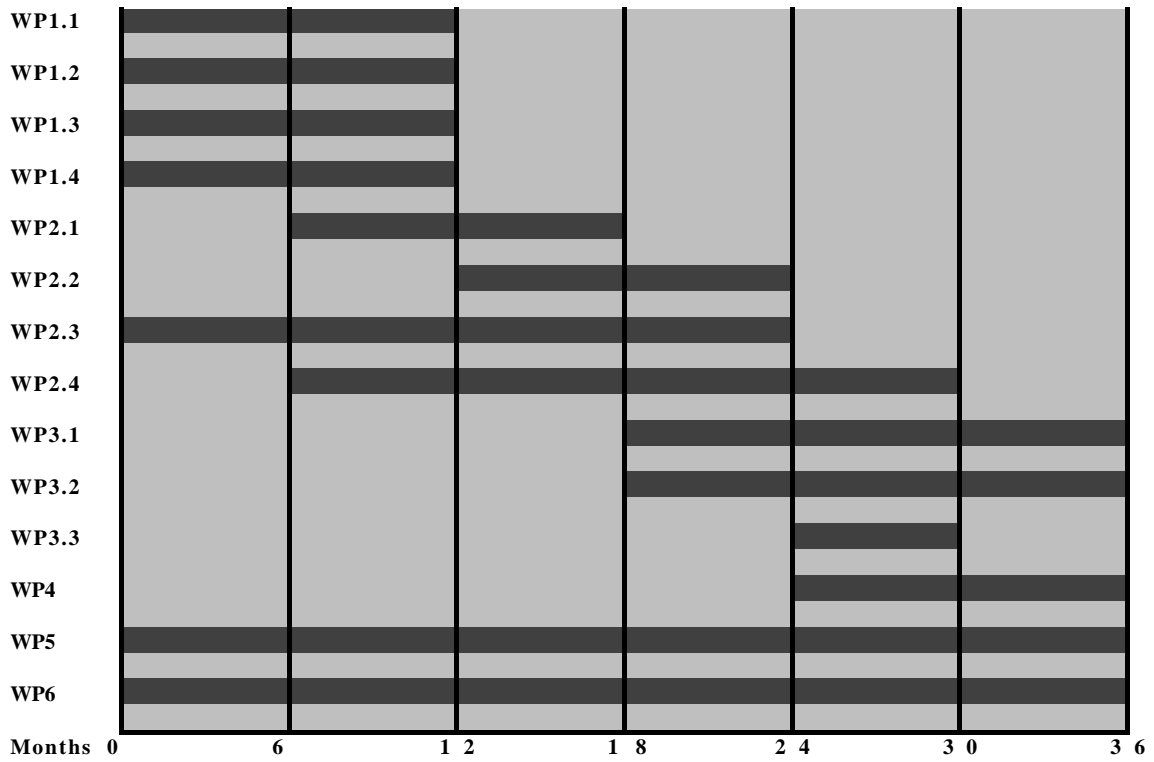
The delay of the Commission in transferring the advance payment to INRIA (delay of 6 months) entailed important difficulties for the African partners, because they do not have any capacity to advance funds.

For the second part of the project, resources had to be re-distributed so as to correspond to the available work capacities. In fact, the CNTIG which is not an academic structure met difficulties to supervise its SIMES WISE-DEV students. Thus a student from CNTIG was assigned to ESP. Also, the change of duties of the person in charge of SIMES WISE-DEV for the University of Dschang (who has then been successively nominated rector of Ngaoundere, and of Douala University), has lead to transfer part of Dschang duties to other partners.

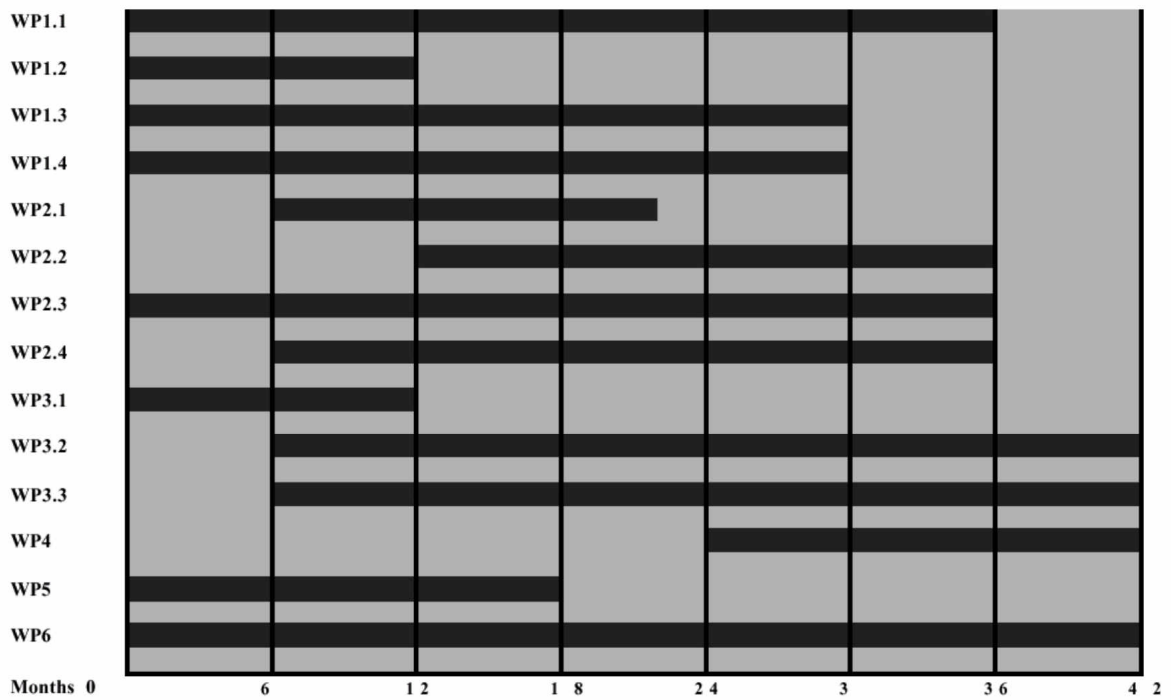
#### **A.4. CHANGES TO THE PROJECT PLAN**

The problems mentioned above entailed the following modifications within the project plan : the total project duration has been extended to 42 months (instead of 36) ; the start and end dates of each Work Package have been revised within this new duration, as indicated on the next page.

*Initial Pert Chart*



*New Pert Chart*



## **A.5. USER REPRESENTATION CONSORTIUMS**

Concerning the Malian pilot operation, 61 Malian scientific and technical staff are involved in the use of the information produced by the fishing Observatory and the afferent model. A micro-computer was set up in the Mopti offices in 2000 so that the members of the fishing and agricultural associations can consult the information of the observatory and use the model to run simulations.

## **A.6. VALIDATION ACTIVITIES**

The pilot operations provide the framework for the validation of the developments :

- Integrated model of Niger Central Delta

This integrated model allows to test scenarii and has been validated by 61 Malian staff for 3 specific scenarii :

- Seeds scarcity: impact evaluation on the production of the Delta of a seeds rice scarcity due to consecutive bad crops.
  - Extension of the water tapping in the Niger river upstream of the Delta: the Niger agency is going to triple its irrigated surface, consequently less water will lye in the delta; the model has allowed to evaluate the impact on productions.
  - Fishermen settle up: after the decentralisation, 80% of the migrant ex-fishermen settle on their original area entailing the drop of the fishing effort on the drop in level and low water concentration areas. The model has allowed to evaluate the impact on fishing production.
- Basic tools for the images processing

The INRIMAGE software developed at INRIA and which includes an open library of basic algorithms of images processing, has been installed in ESP and ESI. Tests have been realised on the aerial images and on ground photographs of the Delta. Users are the project participants, teachers and students. This software constitutes also a common base on which the algorithms developments are integrated.

- Image mosaiquing

Recent algorithms of image mosaiquing developed by Oxford University have been tested on the aerial images and on ground photographs from the Malian pilot operation. These results have been validated by geographers and fishing specialists coming from IRD and IER. An extension of these methods to the matching between oblique images taken from the ground and from a light aircraft, or between such oblique images and vertical aerial images has also been tested. These new techniques have the interesting advantage of working with non calibrated images (i.e. photographs taken without a precise positioning of the camera). They will allow the practical use of low cost photos taken without depending on classical aerial campaigns which have a very high cost.

Therefore it will be possible to follow and analyse almost in real time phenomena taking place in the Delta : raising and drop in level, fishers migrations, agricultural landscape evolution. With a sufficient level of overlap such photographs can be superimposed with the same focal point, and thus recreate a “movie” of the eco-system evolution : on such a movie, it should be possible to intuitively perceive correlations between phenomena that would not appear otherwise. The same superimposition can also be used between oblique images and vertical images acting as references : this should allow to do measurements on oblique images (surface of flooded areas, surface of cultivated fields, etc.), thus allowing to extract quantitative data from these oblique images.

- Fine networks extraction

Recent algorithms of linear networks extraction in images (roads, tracks, rivers, rails...) are also being tested on the aerial images of the Malian pilot operation. These algorithms will permit a better quantitative evaluation of the evolutions.

#### **A.7. CO-OPERATION ACTIVITIES WITH OTHER PROJECTS AND PROGRAMME SECTORS**

Contacts have been established and are followed up with REIMP which is willing to use in the management of environmental information in Central Africa the tools and methodology developed in SIMES.

WISEDEV has also permitted to establish relationships between the SIMES consortium and CIESIN, an American organisation specialised in the environmental information cataloguing. CIESIN has provided to the SIMES WISE-DEV African partners two training sessions, about their system ISITE, used in the United States and in Mexico. These training sessions were organised at Dakar and Bobo-Dioulasso in 1999.

#### **A.8. CONTRIBUTION TO THE APPLICATION DOMAIN**

The goal of the project was to gather skills in computer and environment sciences in order to contribute to improve the information management, processing and dissemination about the environment in sub-saharan Africa.

Two pilot information systems have been set up using SIMES tools and generic platform, they can be accessed respectively at :

- <http://www.ier.ml/peche/> (Fishing observatory in the Niger river Central Delta)
- <http://www.orleans.ird.fr/~chevillo/letouze/letouzey.html> (Cameroon Nat. Herbarium<sup>7</sup>)

Further results can be accessed at :

- <http://www.simes.sn> (On line image processing tools and image mosaicing results, as well as preliminary Senegal river data)

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<sup>7</sup> The Internet connection of the Herbarium having not yet been established, the address indicated is that of the mirror site set up in IRD's laboratory in Orléans.

Some original new ideas have emerged during the project, as to the potential of modern IT techniques for environment applications. Most important, a sustainable know-how transfer has been realised towards African institutions through local training and hands-on collaborative work on concrete problems and tasks. This sustainable transfer was particularly facilitated thanks to the involvement of African partners from both IT and environment fields, which should be able in the near future to continue their initiated collaboration.

The African institutions specialised in Information Technologies (including young specialists within these institutions) have now acquired the necessary specific skills and a good level of understanding of the specificities of environment information and issues. They are thus now in a good position to bring an efficient local support to the environment experts in the maintenance and evolution of the tools and platform developed by SIMES and already used within the two pilot applications ; they also should be able to bring a similar local support to other institutions or environment programs willing to exploit SIMES technology and methodology.

#### **A.9. DISSEMINATION ACTIVITIES AND EXPLOITATION PLANS**

The main dissemination actions have been detailed above in the A2 chapter, within WP6 achievements. Further such actions are listed below :

- 30<sup>th</sup> June 1999: project presentation to the Rector of the Bobo-Dioulasso University and to the local persons in charge of the structure for the environment.
- April 12-23<sup>rd</sup> 1999 in Dakar: Web demonstration of the Fishing Observatory in the Niger Central Delta within the training seminar organised by ICLARM (International Centre for Living Aquatic Resources Management) on the improvement of the fishing management and the bio-diversity.
- December 2<sup>nd</sup>, 98: on the occasion of the Yaounde meeting, project presentation seminar to the persons in charge of the ONG projects and to the representatives of the Cameroonesse Department of Environment.
- May 1998: diffusion of the project objectives in the main newspapers in Senegal, Burkina Faso, Mali, Ivory Coast and Cameroon for the students recruitment campaign.
- 28<sup>th</sup> April 98: presentation of the project to the primature of Ivory Coast at Abidjan in front of the Director of the Prime Minister Department Staff.; intervention in the TV news programme of Ivory Coast.
- 15<sup>th</sup> April 98: presentation of the project to the Director of the fishing and agricultural Minister Department Staff of Mali during the meeting of Bamako.
- December 97: During a trip at Beijing, presentation of the project at the Chinese National Institute in charge of the desertification problems.
- November 97: one sheet article describing the project in the newspaper "le Soleil" (Dakar).

These dissemination actions to non academic structures and to political officials were undertaken so as to ensure the future exploitation of the SIMES WISE-DEV system which will be taken in charge by operational structures a priori far from the academic environment.

## **A.10. DETAILS OF PATENT APPLICATIONS**

There won't be any patent. The results are available free of charge to permit a better passing on of the know-how to the African partners and further institutions or programs dealing with environment issues.

## **A.11. CONTRIBUTION TO TELEMATICS APPLICATIONS PROGRAMME OBJECTIVES**

- What is the economic and social impact of the project?

The SIMES WISE-DEV system will permit a better management and a better dissemination of the information on environment, promoting the transfer to operational and academic African structures of the most recent advanced Information Sciences and Techniques and their application to sub-saharan environment.

In other respects, this system will constitute a base of environmental information which will be shared between scientists, authorities, the press and the public, which will help the emergence of consensus on the orientations of the environmental policies.

- How does the project contribute to the European Union policies?

The WP5 report has been passed on to DG XII and DG VIII and it could lead to a new approach of the European policy towards developing countries. In particular it has been used in a working group convened by the DG VIII on new technologies and developing countries.

Because of its transparency in Africa at the level of the academic structures, agencies and organisms of the environmental management, this project contributes to the action of the European Commission in these countries.

This transfer of know-how to the developing countries involved also corresponds to an orientation of the European Commission policy.

- How does the project contribute to the competitiveness of industry

The project is intended to the African local public structures or to the international organisations (ONGs, Banque Mondiale, PNUD etc...). However, it will clearly have an indirect impact on the local economies.

- How does the project contribute to meeting the needs of identified users?

These countries face difficult environmental problems : deforestation, desertification, over-exploitation, etc. Solving these problems requires a better management and dissemination of all the information components on environment, which is the first objective of SIMES.

The SIMES project can be assimilated to a catalyst or an amplifier dynamic process going from the data acquisition to the dissemination towards the users of interactive and friendly knowledge bases. Thanks to the development of systemic generic tools for the relevant information production, the project should satisfy the users needs. The establishment of



interactive exchanges via the Web is a condition for the success of the project. The main interest of the pilot operations was to define relevant indicators for the environment issues studied, and appropriate to provide a good readability of the environment evolution to the users.

The workshops organised with the users of the fishing activities observatory in Mali made it clear that the information provided, the interface and the model proposed met their expectations.

- What is the Involvement of SMEs in the projects and is the work oriented towards the special needs of this sector?

The Consortium does not include any small- or medium-size company.

- How has the project encouraged the involvement of users in the project and benefited from their presence?

Three partners are already potential users of the techniques developed by SIMES WISE-DEV (IER, CNTIG, and CCT).

The pilot operations (The Fishing Observatory of the Niger Central Delta and the Herbaria information system) are actually a place for the exchange and dialogue with the users. Users find a place where the scientists expertise can help their information needs. Concerning the Niger pilot operation, the choice of the sites has been motivated by the users information needs around the problem of the decentralised management of the fisheries. Moreover, others participate to the process through the data acquisition in view to perpetuate the observatory.

As a crossroad place between thematicians and computer scientists, the project integrates the users needs through the two pilot operations, when the goal is to produce relevant information with a shared knowledge base. International forums and the Web are communication and exchanges privileged means with different users which can be the representatives of organisms as FAO, UNDP, the World Bank, the European Union or research scientists.

- What is the European added-value of the project, in terms of inter-operability and multilingual services and products?

The final goal of the integrated system is to support the co-operation of heterogeneous tools on distributed heterogeneous data. Thus inter-operability is one of the main goals of SIMES methodology and technology. The multilingual aspect is not really the matter.

## Part B - Future project plans

This chapter is not really applicable for the present final report. Nonetheless it is worth mentioning that beyond the project closing date, the pilot operations will continue, using the partners own resources, and as well with other external fundings (some of which have already been secured : KFF 700 from the Fonds Francophone des Inforoutes and from the French Cooperation).

In Mali, the data acquisition will continue within the Fishing Observatory and new bulletins will be available every six months. The management of the Observatory will be passed on from IER to an operational structure (OPM : Opération Pêche de Mopti). And a “restitution” workshop has been organised, which will be held in Bamako in next July.

As to the Herbaria, the specimens information acquisition will continue in Cameroon’s National Herbarium (already two plant families have been treated, and a third one is under way). An important effort will now be dedicated in the coming year to the equipment of Dakar’s Herbaria, starting with IFAN’s Herbarium, which is already fitted with a specific PC NT, Oracle and the same data model and interfaces as are used in Yaounde : IFAN’s Herbarium computing equipment will be completed with three more PCs dedicated to specimens data input, and with a numeric camera to capture images of the “type” specimens (the specimens on which taxons descriptions have been based ; the availability of these images will be particularly usefull for botanists and avoid many physical exchanges of specimens, as well as facilitate the preparation of botanists missions in Dakar). It is so far planned to equip at least six Herbaria in Western and Central Africa with the same system.

Moreover the consortium plans to submit a proposal for a SIMES 2 project to INCO-DEV in September 2001, with a likely extension to Latin America (a partnership is under study with IDEAM in Colombia, a very modern institution in charge of the monitoring of environment and particularly of bio-diversity, using complementarily teledetection and ground data acquisition techniques), or in Asia, for instance in China where the Beijing based LIAMA (laboratory co-founded by INRIA and the Beijing Automation Institute, already involved in several IT/environment important projects) could be a prominent partner. This project could play a pilot role in testing the “umbrella project” approach suggested for the 6<sup>th</sup> FP of the European Commission, as mentionned in Chapter A2 paragraph WP6.

Orientations for SIMES 2 are sketched in the chapter “**Conclusion and future orientations**” here-below.

## **Part C - Plans for demonstration and exploitation**

### **C.1. WHAT IS THE LIKELY THRUST AND DIRECTION OF YOUR EXPLOITATION PLAN?**

The exploitation plan has been described in the project program. This plan includes especially the validation of the pilot systems and the use of the generic system SIMES within the context of other environmental observatories. A transposition of the Malian pilot operation is already foreseen in Burkina Faso; a proposal has been submitted by the Fishing Direction of the Burkina Faso to the World Bank. The main part of the research activities led by IRD in Africa deals with environment issues and numerous observatories are implemented. Their information systems will be realised with the help of SIMES. The idea is to constitute a network of observatories, which will facilitate the global control of environment in Africa.

### **C.2. DO YOU FORESEE MOVING TO AN IMPLEMENTATION PHASE OF THE PROJECT, PERHAPS IN SOME OTHER EU ACTION?**

Not an implementation phase, which was already included in SIMES ; more an extension of the validation of the tools and methodology already implemented, an exploration of new IT techniques, and an extension of the use of the techniques developed, to further environment applications.

### **C.3. DEVELOPMENT AND/OR ENHANCEMENT OF SERVICES.**

The open architecture chosen for the software common base, which permits the implementation in network of processing modules, is well adapted to the integration of new algorithms.

### **C.4. IMPACT OF WORK, INCLUDING WORLD LEADERSHIP, CATCH-UP AND KNOW-HOW.**

SIMES is a pilot project because it merges African (sub-saharan Africa) and European skills to lead, within African academic structures, studies to use the most recent Information Technologies techniques for the control of sub-saharan environment. SIMES results are certainly promising as to the catching up by Africa on its delay in mastering its critical environment issues. SIMES has dramatically changed the perception of the African environment related partners as to the potential of modern IT techniques, and it also has already brought important changes in the day-to-day work of these partners.

The project organisation itself, as detailed in the previous chapters, has ensured a sustainable technology and know-how transfer, both from IT to environment specialists, and from northern laboratories to African institutions.

### **C.5. FUTURE PLANS, COMMERCIAL AND MARKET POSSIBILITIES, RESULTS EXPLOITATION.**

Within the SIMES project, fifteen African students have been recruited by the five African structures in order to prepare a Master degree or a Ph.D. related to the project thematics.

Three Ph.D. theses will be completed in 2001 and nine Maîtrise or Master degrees have been already obtained. Among these young specialists, who have been trained and have worked on site, within their local institutions, many have already been recruited on permanent positions in the partner or other local institutions. They will bring these institutions new skills and enhance their capacity to exploit SIMES results on the long term.

Other aspects of future plans and exploitation of SIMES results are dealt with in the previous and next chapters.

#### **C.6. DEMONSTRATIONS, FINDINGS, CONCLUSIONS AND FUTURE POSSIBILITIES.**

These aspects are treated in the previous and next chapters. Particularly, future orientations for a SIMES 2 project are sketched in the chapter “**Conclusion and future orientations**” here-below.

#### **C.7. END PRODUCTS OF THE PROJECT, COMPLETE THE FOLLOWING FORM.**

- Generic platform with its user interface
- Acquisition and processing tools, integrated within the platform
- Integrated multi-layer model of the Niger Delta socio-ecosystem
- Expert system for plants identification
- Information systems set up for the two pilot applications

## Conclusion and future orientations

The project was organised so as to bring together skills in computer science and in environment, in order to contribute to the improvement of information management, processing and dissemination about the environment in sub-saharan Africa. This approach has proven to be very effective, and a real synergy has been created between the specialists from these two domains.

New ideas have emerged as to the possibilities offered by the latest IT techniques in dealing with complex environment issues. Environment specialists have come to a good level of understanding of the IT techniques ; and IT experts have discovered new areas of application for algorithms that had been developed initially for other purposes (e.g. algorithms developed for robotics, or for medical images).

After the final review in Brussels, the evaluation team required that a new project “SIMES 2” be proposed. Here are briefly presented the considerations which should guide the conception of such a project.

The following aspects of SIMES organisation and achievements are particularly favorable to a long term exploitation of the project’s results within the two existing pilot operations, and to the promotion of SIMES techniques and methodology in future other operations :

- The important dissemination effort undertaken during SIMES
- The numerous relationships established with external programmes and potential users
- The presence within the consortium of African partners in charge of environment monitoring (CNTIG, CCT)
- The presence within the consortium of African partners in charge of research programmes on environment (IER, IRAD), and the experience they have gained in using emerging IT techniques
- The strong involvement of African institutions specialised in IT technologies (ESP, Dschang University, even ENSP Yaounde which is now involved in the second pilot operation) : an important know-how transfer has been realised from the european and american partners towards these institutions, and they are now in a position to ensure the local maintenance of the tools developed, and to participate efficiently in future further developments
- The long term involvement of IRD, and at a lower level of INRIA, in Africa, and the strong relationships they have both established with African organisations.
- The strong presence of IRD in Africa, with permanent offices established in all countries involved.

The following avenues should be explored in order to set up an efficient project SIMES 2 :

- Build on the results already obtained in terms of tools and methodology
  - Improve the software robustness and genericity
  - Organise light aircraft regular aerial pictures shooting campaigns, so as to test the possibilities offered by the automatic registration of oblique non calibrated

- images, in order to follow the co-evolution of socio-ecological phenomena, and intuitively detect correlations (by reconstructing a “movie” of the socio-ecosystem evolution on a significative period) or measure quantitative parameters (by the registration of each oblique image with a vertical aerial image of the same area).
- Reinforce the integration of the various tools developed within the common platform
  - Build on the results already obtained within the two pilot operations
    - Transpose the fishing observatory structure, tools and methodology to other areas (a proposal has already been submitted with FAO and the Fishing activities department in Burkina Faso to the World Bank ; the observatory could be transposed with minimum adaptations to other sites with an important fresh water or coastal marine water fishing activity)
    - Install the information system architecture and nomenclature developed in Yaounde Herbarium in other Herbaria (this has already been done within SIMES in the Herbarium of IFAN in Dakar, rich of 100.000 plant specimens covering all Western Africa ; it is already planned to install the same system in 4 other Herbaria –another one in Dakar, one in Abidjan, and two other ones in Cameroon-), so as to build a distributed information system on African collections accessible from a common gateway (gateway which can be mirrored on the site of each institution involved)
    - Extend the information capabilities to handle data on the various usages of plants
  - Explore new types of environment issues
    - A first one has already been proposed by CNTIG with the monitoring of deforestation in Ivory Coast
    - In a similar domain, interesting contacts have been incidently taken with IDEAM, a Colombian institution in charge of environment and bio-diversity monitoring : an operation is proposed on the monitoring of the evolution of Colombian vegetation, using teledetection and ground data. This operation would provide an interesting opening on another continent, using techniques developed in Africa.
    - Another operation for which preliminary steps have been taken is the environmental observatory of the Senegal river valley (which was originally selected as the second pilot operation) : this observatory has taken longer than foreseen to be set up by the tripartite authority OMVS<sup>8</sup> ; it now seems to be in a stage where an effective operation can be started to set up an information system in support of the observatory.
    - Numerous other areas of application could be explored, considering the good level of genericity of the methodology and tools developed by SIMES, especially concerning the common platform and gateway techniques.
  - Explore new IT techniques

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<sup>8</sup> Organisation pour la Mise en valeur de la Vallée du fleuve Sénégal, jointly run by Senegal, Mauritania, and Mali

Numerous techniques under development within INRIA laboratories and other european partners laboratories could prove very usefull to process or organise environmental information :

- Image indexation techniques, using images signatures (associated or not with keywords)
- Document automatic analysis : documents XML marking up, ontology extraction, with applications in text mining, semantic navigation, constitution of standardised nomenclature from the available litterature, or normalised descriptions for plants or other environment items.
- Computer assisted identification of plants, birds, fishes, insects, bacterias, etc. The first expert system developed within SIMES for the identification of plants within the Caesalpiniaceae family has shown that such an operation is feasible, is interesting for botanists and technicians, and as well that a number of improvements could be brought relatively easily to the language and related tools which are so far available to set up such systems.
- Etc.

These avenues are certainly well worth exploring. A SIMES 2 project, with the same principle of co-coordination by IRD focusing on the applicative side and INRIA focusing on the IT side, with a similar or appropriately extended consortium, with the same organisation including several typical environment applications and testing processing techniques from various complementary IT domains, and with a similar funding structure, should be an ideal way to explore these avenues and build up on SIMES results.

Moreover, SIMES 2, if starting early in 2002, could be considered as a pilot project for the European Commission, in order to test the “Umbrella project” approach, mentionned in Chapter A2 under paragraph WP6, as being a particularly efficient way for DG INFSO to organise future R&D activities on IT applied to environment within FP6 (2002-2206).

## **Supporting information**

Here below are presented the abstracts of all SIMES deliverables.

### **D1.1 Spécification de l'Architecture du Système d'Information SIMES**

This document presents an informal specification of the Information System SIMES (Multimedia System Information for sub-Saharan Environment). SIMES can be seen in two different views : an analytic one focused on its components making SIMES be a tools box, and a global one where the federative aspect of the software components is enhanced. Here, we present the Software bus.

### **D1.2 Conception des systèmes d'information des observatoires environnementaux : Une architecture de médiation**

This document describes a detailed proposal for the Man Machine Interface of SIMES project. It follows the document entitled "Specification of the Information System SIMES". This part of the architecture takes place above the detailed section "An architecture for heterogeneous distributed environments" using its services.

### **D2 Project Conventions**

In order to improve the project management, specific conventions have to be adopted. These conventions shall complete the rules which are already included in the Project Programme and shall focused on the organisational aspects such us: financial management, documents organisation, web architecture, official reports...

### **D3 Software development**

This document proposes an implementation for a common tool to realize the access support to distributed objects on a net following the Corba technology. It is an installation guide of MICO tool on Windows 95/NT and also an user manual. MICO can also be implemented on numerous systems. MICO is a free ware. This guide is for the use of SIMES partners and particularly for pilot operations. It has been successfully experimented. This work has been realized during the stay of Georges Edouard KOUAMOU at LORIA in Nancy, June to September 1998.

### **D4 Procédés d'intégration**

This document describes a possible approach for the development of the architecture proposed for SIMES. This work has been realised during the stay of Georges Edouard KOUAMOU at LORIA in Nancy, June to September 1998. It complements the document on



general specifications and goes with the document on the detailed conception of the Man Machine Interface.

## **D5 Functional Description of the data**

This document has been written within Task 1.1, Work Package 1, of the SIMES WISE-DEV project, as the deliverable of Task 1.1. It aims at giving a functional description of the data identified within the two pilot operations mentioned in the SIMES WISE-DEV Project Programme. Functional description means here the semantic description of the data, ie. the related field (hydrology, fisheries, demography, etc.), the meaning of the variables (water level, fish size, etc.), the unit, the acquisition procedure (direct measurement, calculation, estimation, etc.), the standard variation, and so on.

This functional description is complemented by an electronic description presented in the document « Electronic description of the data » which gives all necessary information on the electronic format of the stored data, to be used in the design of algorithms, and the development of programs to be applied to these data.

In this document more details are given on the data issued by the Malian pilot operation than on those issued by the Senegalese operation. This is due to the high degree of maturity of the Malian operation, and to the very preliminary stages where the Senegalese operation remains so far. Further detail on the Senegalese operation data are expected to be available for the second quarter of 99.

## **D6.1 Procédures de stockage et d'organisation des données dans une base de données**

This report establishes the various schemes which will be implemented :

- To define transfer and extraction links with the existing Data Bases containing the data related to the relevant indicators, such as the ones described in the deliverable « Functional description of the stored data », by taking into account the heterogeneousness of Data Bases and the evolutivity of the system.
- To organise and store these data in a centralised Data Base whose master copy will be installed at ESP dakar. This Data Base, linked to a Web server will allow to access to the data via Internet. The goal of the project is to create a Web interface which suits to potential expected users and requests. To achieve this goal, we will rely on work done by other teams in advanced data processing (Image processing, multi-agent systems...).
- To specify and to test on an actual case a prototype including some key functionalities of the forthcoming system.

## **D6.2 Electronic description of the data**

This document has been written within Work Package 1, Task 1.2 of the SIMES project, as the deliverable of Task 1.2. It aims at describing the electronic format of the data identified within the two pilot operations mentioned in the SIMES Project Programme. Its aim is to

enable the further specification of algorithms to be applied on these data, which will be developed within Work Package 2 of the project.

### **D6.3 Electronic description of the data (Herbaria)**

This document is a complement to deliverable D6.2 "Electronic description of the data". It presents the Conceptual Data Model used to computerise and manage the collection of an Herbarium.

This model is already used in the National Herbarium of Cameroon, and is to be replicated in four other Herbaria of Western and Central Africa. The model is based on "referentials" (i.e. standardised indexes of names, with a hierarchical structure and the management of synonymy, covering respectively the fields of botanical taxonomy, habits, botanists, localities, and plants usage categories).

The collection data and the data on plants usages are linked to these referentials. The referentials are used within the input interfaces, so as to avoid the discrepancies between the various names variants which are often encountered in the usual botanical databases. This approach allows a proper exploitation of the databases, as well as their interconnection via the Internet. Exchanges of data, links between specimens and usages, and even distributed interrogations are thus made possible.

### **D7 Data pre-processing**

This paper is the deliverable due at the end of the task WP1.3 of work package 1 of SIMES WISE-DEV project. It describe some algorithms of image pre-processing which can be used on remote sensing images on sub-Saharan environment. These algorithms are mainly based on image restoration and contrast enhancement techniques.

### **D8.1 Functionnal description of pertinent indicators**

This document has been written within the Work Package 1, Task 1.4 of the SIMES WISE-DEV project. It gives a description of the relevant indicators identified for the observatory of the fishing activities in the Central Delta of the Niger river in Mali (Mopti region). The elaboration of this document fits within the context of the recommendations on sustainable development stemming from the RIO Earth summit in 92.

This work deals with the design and testing of indicators that should be used to evaluate of the degree of sustainability of a development, i.e. the quality of the interaction between a society and its environment. Following an approach recently adopted by IFEN (Institut Français de l'Environnement), 62 indicators distributed among 16 semantics related to 6 axes of fishing surveys have been described, including their calculation modes, their appreciation scales, and the related data sources.

## **D8.2 Interface prototype specification**

The DCN fishing activities Web site is one of the first steps in the current research process which concerns the conception of an environmental observatory Information System in this region. In this document, we present this experience and we focus on the User Interface specification and the needs due to the specificities of this type of Information System especially in terms of navigation.

This document is a part of the Work Package 1, Task 1.4 of the SIMES project.

## **D9 Démonstration du prototype d'interface utilisateur**

This document summarises a demonstration accessible through Internet on the Malian pilot operation information system.

## **D10 La société de l'information et l'Afrique subsaharienne**

This report has been prepared within a working Consortium established in the frame of SIMES project founded by european program INCO. The working Consortium has met two times : November 20<sup>th</sup>, 1997 in Dakar; April 27-29 1998 in Abidjan. The composition of the Consortium is given in Annex V.

## **D11 Modelling**

This document presents the use of the most recent data processing methods (image processing, statistical analysis, symbolic representation, modelling, expert systems) to analyse SIMES data (see WP1 "Data acquisition" : D6 to D8). The validation of SIMES technology is realised within the two pilot operations, with a particular focus on the first pilot operation for image processing, statistical analysis and modelling ; and on the second pilot operation for expert systems.

The main developments are related to the integrated model of the Niger Central Delta socio-ecosystem, to various image processing modules, and to an expert system for plants identification.

## **D12 Parameters extraction**

This document follows Deliverable D11 and presents how to use image processing algorithms results (regions, contours, typical points) in order to get semantical information relevant for end-users. This information could be for instance used as input for the Niger Central Delta integrated model presented in Deliverable D11.

### **D13 Registration of spatialised data**

This document describes the techniques developed within the consortium for the registration of spatialised data and the mathematical grounds of these techniques. The application of these techniques, selected as the most relevant for SIMES WISE-DEV's needs, is the mosaicing of aerial images of the Niger river Central Delta.

The document details the algorithms used to automatically compute the relevant homographies for the registration of original adjacent images and to apply these homographies to obtain the image mosaic requested on line by the user, according to the scale and center specified.

The main advantage of this method is its robustness, and particularly its capacity to handle non calibrated images (i.e. the orientation and altitude of the camera used during the shooting of the aerial photographs does not need to be known).

### **D14 Demonstration for WP2 on the pilot operations**

This document gives a brief description of the set of demonstrations on processing techniques (WP2) which have been shown during SIMES Final Review, Feb. 2, 2001. The processing techniques were demonstrated on the concrete examples provided by both SIMES pilot operations, i.e. data from :

1. Fishing activities monitoring system, in Niger river Central Delta, in Mali
2. Plants biodiversity distributed information system, West. & Cent. Africa (based on Herbaria collections)

The three main aspects covered by the demos are :

1. Image processing : registration, mosaïcing, segmentation and contours detection and tracking on aerial images of Niger Delta
2. Modelling : multilayer integrated model of Niger Delta socio-ecosystem
3. Plant Identification : expert system for plant identification to the genera level

### **D15 Storing new information**

This document describes the mechanisms available in the generic SIMES platform to store new documents either produced by processing tools activated from the platform, either being parts of an existing data base, or being available somewhere in an acceptable electronic format. The approach relies on the following architectural choices Web, Coldfusion, Corba, and Com.

### **D16 User manuals for the pilot operations**

This document presents three typical user manuals : the two first ones are linked to the Fishing Observatory and the related Integrated Model of the Niger Central Delta socio-

ecosystem (pilot operation 1) ; the third one is linked to the National Herbarium of Cameroon and its database (pilot operation 2). The first manual can be adapted to other fishing observatories that could be set up with the same approach in other areas of Sub-saharan Africa, such as the one in project for the two main lakes of Burkina Faso (proposition FishDev submitted to World Bank's *InfoDev* program).

The third manual is to be used as is by all African Herbaria partners of the project "Computerisation and networking of African Herbaria" placed under SIMES umbrella, and already benefiting of a first complementary funding by the Francophony Agency. The second manual is of course specific to the Integrated Model developed for the Niger Central Delta, however it gives a good example of the use of socio-ecosystem models of this type that could be developed in other areas.

### **D17 Presentation booklet of the server on the second pilot application** **"African Herbaria computerisation and networking"**

This document gives a brief description of the Web interface for the databases to be set up in all African Herbaria partners in the second pilot operation. The Web interface navigation functions have been designed so as to allow a global navigation through the network of databases.

The pilot site for this operation is Yaounde Herbarium : the database in Yaounde is already fully operational, and the collection computerisation, which should take about three years, has now entered a routine phase ; a first botanical family has already been fully entered. Four other Herbaria are yet partners in the project : 2 in Senegal, 1 in Ivory Coast, 2 other ones in Cameroon ; installation of the system in these Herbaria is planned to be completed by end 2001.

The Internet connection of Yaounde Herbarium unfortunately does not yet allow a direct access to its Web interface ; but the database is mirrored in IRD site in Orléans, and is accessible at <http://www.orleans.ird.fr/~chevillo/letouzey/letouzey.htm> .

This document constitutes deliverable D17 ; a documentation on the local interfaces to be used by the Herbaria staff for input and local exploitation is given in deliverable D16 ("User manuals for the pilot operations").

### **D18 Presentation booklet of the server on the first pilot application** **"Niger Central Delta"**

This document presents the Web site set up by IER and IRD for the information system built in support of the Observatory of the fishing activities in the Niger Central Delta. These information system and Web site constitute a precious dissemination device for the information produced by the Observatory, towards the final users (fishers communities representatives, local, national and international authorities, NGOs, scientists).

The document gives a brief overview of the context, motivations and issues, before describing the system organisation, implementation and interface.

### **D19 Data processing tools integration**

In this deliverable is first presented the techniques used for tools integration on the platform, the approach and the global schemas of the platform with tools. An abstract object "tool" is defined which enables the definition of a unique protocol to exchange with tools (calling, parameters passing, exceptions, etc.) regardless of the implementation choice for the tool encapsulation (command script, Corba style or D-Com). It contains also a tool installation guide on the platform and a guide for using an integrated tool.

### **D20 Data acquisition tools integration**

Relying on the protocol and the abstract object "tool" defined in D19, here is defined and abstract object "Data warehouse" which can be any means of information storage.

The cases of integrating a new data base, a file directory or a file are described.

Other types of information: short texts, mail, discussion forum, chat contents, calendars, agenda are also described thanks to a specific GroupWare system used as support of the general integration.

A data warehouse integration guide and a user guide completes the deliverable.

### **D21 Pilot application “Niger Central Delta”**

This document describes the environment and IT issues and achievements of the first pilot operation, i.e. the information system set up by SIMES in support of the Fishing Observatory run by IER in the Niger river Central Delta. This system was demonstrated in Brussels during the final review and is accessible on IER's Web site at <http://www.ier.ml/peche>. The system encompasses the data acquisition, pre-processing, organisation and dissemination procedures and tools developed by the SIMES consortium.

### **D22 Pilot application “African Herbaria computerisation and networking”**

This document describes the environment and IT issues and achievements of the second pilot operation, i.e. the information system set up by SIMES in within the National Herbarium of Cameroon in Yaounde and within IFAN Herbarium in Dakar, and to be replicated in other African Herbaria, so as to build up a network of coherent databases on African collections. Four Herbaria are already partners in the operation beyond the two first ones (one more in Dakar, one in Abidjan and two more in Cameroon).

The system was demonstrated in Brussels during the final review and is accessible on IRD's Web site at <http://www.orleans.ird.fr/~chevillo/letouze/letouzey.html>. The system facilities encompass the data acquisition, pre-processing, organisation and dissemination procedures and tools (expert system for plants identification) developed by the SIMES consortium.

### **D23 Demonstration for WP3**

This document describes the demonstration performed in Brussels during the final review for the SIMES common platform and gateway interface, with as main functions :

- information querying
- processing tools distant running
- new information, documents or tools integration
- system general administration

### **D24 Demonstration for WP4 on both pilot operations**

The content of this deliverable was considered as covered by the previous deliverables D14, D16-18, and D21-23.

### **D25 Exploitation report on the quality procedures**

This document describes the principles and techniques used in the SIMES project development activities so as to ensure the appropriate quality level for the resulting software and deliverable documents. Standardisation, genericity, openness, strict life cycle and systematic internal reviews are here the key elements.