



EAMNet
Europe-Africa Marine EO Network



EAMNet: Europe Africa Marine Network

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1 Executive summary

EAMNet has resulted in improved interaction between African and European information providers, user networks and centres of excellence, addressing the priority lines identified under the 'GMES and Africa' initiative on Marine and Coastal Areas and Capacity Building. In achieving this EAMNet has left a legacy of improved infrastructure and capability in training and experience. Specifically:

- Providing the best quality EO data products to Africa complementing GMES initiatives (MyOcean) and the OSI-SAF.
- Providing 5 operational GEONETCast systems.
- Disseminating best practices through exchanges of personnel between partners.
- Creating and presenting an EO Masters-level module at UCT, UDSM, UG as well as other universities
- Establishing a regular marine science presence at AARSE conferences involving African marine scientists and stakeholders and key European partners in FP7 or ESA GMES projects
- Newly trained personnel from a wide range of African Universities able to use GMES data

EAMNet has impacted at a number of levels and for a number of programmes, including:

- The aims of the European Commission FP7 SPACE call.
- GMES and Africa Marine and Coastal Areas and in the Capacity-Building Framework.
- The EU Africa Action Plan (2008 -2010): specifically (8) Partnership on Science, Information Society and Space: Priority Action 2: Support S&T Capacity Building in Africa and Implement Africa's Science and Technology Consolidated Plan of Action (CPA) Priority Action 3: Enhance cooperation on Space Applications and technology.
- African marine and coastal management agencies.
- The GOOS Africa Regional Ocean Observing and Forecasting System (ROOFS) specifically to “WP2. Facilitate access to and training in satellite remote sensing, applied to marine and coastal environments” “WP1. Build an African network of in situ ocean observing stations, for monitoring coastal zones and the impacts of climate change.” EAMNet also contributed to the integration between the GOOS-Africa Large Marine Ecosystems by providing consistent EO datasets for each LME
- The Group for Earth Observations through its contribution towards development of the GEO System of Systems via GOOS Africa.
- Finally, and arguably of highest importance, EAMNet has impacted directly on individual scientists, universities, training institutes and professional bodies.

2 Summary description of project context and objectives

The overarching objective of EAMNet is to create a network addressing the aims of the FP7-SPACE SPA.2009.3.2.01 International Cooperation call, noting the elements highlighted in the Lisbon Process on “*GMES and Africa*”. The network aims to bring together marine and coastal information providers, user networks and centres of excellence in Africa and Europe, following the 'GMES and Africa' priority lines. The goals are to improve coordination of GMES R&D and services activities in Africa, improve the access and use of EO data and increase data exchange and contribute to the development of GOOS-Africa as the African contribution to the worldwide GEO System of Systems.

Each of these specific objectives is described in detail below. Due to the desire to make the project highly interconnected, work packages address more than one objective. For instance, installation of GEONETCast receivers (WP230) will increase access to data and increase data exchange (objective 1), and will also lead to increased use of EO data and contribute in a concrete way to the development of GEOSS and GOOS-Africa (objective 2). Exploitation of the data will feed into improved coordination and interaction with European GMES R&D activities (objective 3) and lead to a more informed contribution to the EU AU Action plan (objective 4).

Objective 1: To improve access to marine EO data, increase data exchange and encourage increased use of EO

The first objective is to improve marine EO data provision for African countries, increase the access to those data and to exchange knowledge of the value and application of the data. This will be done by adding new regions of interest to those already processed by PML and UCT within the DevCoCast project to provide complete daily near-real time coverage of the African coastline at ~1-km resolution. The products to be produced include: chlorophyll-a (an estimate of phytoplankton standing stock) and radiances (from the European MERIS sensor and the US Aqua MODIS sensor) and sea-surface temperature (SST) data (from various European and US satellites). In addition, coastal altimetry data will be supplied from NERC as developed in the AltiCoRe project. These three data types are particularly valuable for medium resolution coastal and marine monitoring.

Access to near-real time data has a number of scientific and environmental monitoring applications including

- Monitoring of algal biomass in relation to harmful algal blooms and eutrophication.
- Coastal movements of sediments.
- Location of fronts, eddies and upwelling, which are often preferential locations for fishery stocks.
- Initialisation and update of numerical models.

The new data areas will be disseminated by GEONETCast and provided via a back-up web site to users in Africa and Europe. This dissemination will directly address the call aims to provide opportunities for more data exchange with international partners, in the area of environmental monitoring and should thereby increase the use of Earth Observation data.

The GEONETCast reception network will be enhanced by installation of 5 new systems around Africa, complementing existing DevCoCast marine systems in Ghana, Tanzania, Senegal, South Africa and Namibia. It should be stressed that the marine data will also be received by all existing GEONETCast users in the land, atmospheric and meteorological communities (with over 100 users). Access to marine data by the meteorological community will be of benefit: for example, higher resolution, higher quality, SST and ocean light attenuation data will support better model initialisation and assimilation and, hence, better model predictions. Such synergetic uses will be promoted through the annual meetings.

EAMNet shall also annually review and report on the availability of marine and coastal EO data from all GMES related projects. In particular, MyOcean the GMES marine core service is constructing a system for providing EO and other data. This project started in 2009 and is providing global and medium resolution data, much of which will be of value for Africa. However, MyOcean will not provide higher (1-km) resolution data for ocean colour and SST. It is, therefore, important that EAMNet takes account of such developments and limitations and the project aims to harmonise between existing (e.g. ChloroGIN Africa) and the new MyOcean data sets in terms of algorithms and data formats. Hence, we shall make recommendations on the direction to be followed for data providers at the start of the project.

Archived data from 1997 (SeaWiFS) and 2002 (MERIS and MODIS) and possibly from AVHRR or AATSR will be supplied on DVD in the same format as the near-real time data. Access to long-term consistent data sets is obviously invaluable for observing monthly, seasonal and inter-annual variability for:

- Computation of “indices” such as the timing, magnitude, duration and decline of blooms and analysed in relation to fisheries, or
- analysis of physical processes such as upwelling in relation to the large-scale wind field, or currents that can impact local climate.

In verifiable terms:

- EAMNet will undertake annual reviews of data available from GMES and other projects ensuring the best quality products are available for use in Africa (W210).
- EAMNet will increase data coverage over African coastal waters “filling the gaps” in existing data sets (WP220, Milestone 1, M1).
- EAMNet will install 5 new GEONETCast reception systems (WP230, M2).
- EAMNet will extend and operate the existing ChloroGIN web data portal to mirror data supplied by GEONETCast (WP240, M3).
- EAMNet will promote the exploitation of GEONETCast and GMES data through involvement in biennial AARSE conferences and planned AMESD meetings (WP530, M10a, b, c).

Objective 2: To develop long-term sustainable approaches to capacity building in marine Earth Observation

A major objective of EAMNet is to contribute to the GMES and Africa Capacity-Building Framework priority line: “Development of human and technical capacities”. It will do this in two ways. First by contributing to existing training courses planned by the JRC, AMESD, DevCoCast and POGO providing a GMES Africa focus and exploiting the data provided through objective 1. This will be cost effective by avoiding duplication with existing activities in Africa. The second approach is to design and implement marine EO modules within undergraduate and postgraduate courses in south, east and west Africa. To ensure a wider dissemination and a long-term impact, lecturers from Universities and training institutes in other African countries will be invited (and supported through the project) to undertake the courses and provided with all course materials. The courses will also be available on DVD and disseminated via GEONETCast. The aim is to increase the number of scientists, technicians and engineers confident in the use and value of EO data.

In verifiable terms

- EAMNet will contribute GMES Africa expertise and materials to existing training courses run by JRC, AMESD, DevCoCast and POGO (WP320).
- EAMNet will develop marine-EO focussed modules for African university courses as the basis for capacity building in those courses as well as in other African Universities and training institutes (WP330-350, M5-M8).

Objective 3: to support development of GOOS Africa as a contribution to a worldwide observation system and improve coordination of existing GMES research and services activities in Africa

EAMNet objective 3 is to support the development of GOOS Africa as the African marine contribution to GEOSS, the GEO System of Systems. It will specifically address two work packages of the GOOS-Africa Regional Ocean Observing and Forecasting System (ROOFS: GRF IV Document 4.1.11 GOOS 4th Regional Forum, Guayaquil, Ecuador, 25-27 November 2008):

- WP1. Build an African network of in situ ocean observing stations, for monitoring coastal zones and the impacts of climate change.
- WP2. Facilitate access to and training in satellite remote sensing, applied to marine and coastal environments.

It will achieve this by providing continuous near-real time EO data for all coastal regions of Africa covering all of the GOOS-Africa Large Marine Ecosystem areas:

- Agulhas and Somali Current Large Marine Ecosystems (ASCLME)
- Benguela Current Large Marine Ecosystem (BCLME)
- Canary Current Large Marine Ecosystem (CCLME)
- Guinea Current Large Marine Ecosystem Centre (GCLME)
- Mediterranean Sea

EAMNet will also build on existing experience in Africa through targeted fellowships, twinning centres of excellence in Africa or Europe with partners in Africa, with the objective of disseminating best practice in areas such as operational oceanography or environmental monitoring utilising GMES EO data. EAMNet will promote the aims of GOOS Africa annually through the symposia at AARSE and AMESD or equivalent.

In verifiable terms:

- EAMNet will operate the enhanced data coverage established in objective 1 for the duration of the project (WP220, M1)
- EAMNet will deliver a minimum of 12 targeted exchanges of personnel and a minimum of 15 open fellowships within Africa, or between Africa and Europe, to train mid-career scientists in best practices in EO data processing and developing applications in the service of society (WP410 and 420, M9)

Objective 4: To create a forum for African engagement in GMES Africa

EAMNet brings together work package leaders and researchers engaged in various European GMES projects with key stakeholders in Africa. This will be achieved primarily by face-to-face contact through the annual symposia and by newsletter, web-site and e-mail contact. The relationships thus established will provide opportunities for African research and data users to influence development of the next stage of GMES. Additionally, participants in European GMES projects will be able to promote the value of African engagement in the GMES process and greater involvement in the Framework 7 programme. The link with the AMESD programme, which is managed by the African Union Commission and steered by the African Regional Economic Groupings, will provide a good political visibility of EAMNet and Earth Observation applications, and encourage these entities in pursuing their efforts at institutional, financial, and technical level, towards “*GMES and Africa*”.

The project will engage with external networks that are key to the development of international observing systems (such as GEO) and in the marine sector (POGO) and focussed on Africa (AMESD).

The project will also attend GOOS Africa strategy meetings. The objective is to provide two-way communications between African needs and opportunities provided by international projects.

Finally, the project aims to ensure a wide engagement in the preparation and further development of the *Action Plan for GMES Africa Partnership* through consultation with GOOS-Africa, AMESD, AUC and other key entities.

In verifiable terms:

- EAMNet will operate an information web portal (WP510, M3)
- EAMNet will publish three-monthly newsletters (WP520)
- EAMNet will, where feasible, organise three symposia concurrent with two AARSE conferences (in 2010 and 2012) and one AMESD user forum (in 2011) (WP530, Milestones 11a,b,c)
- EAMNet will engage with other external networks and organisations such as POGO, GEO, AMESD and GOOS Strategy meetings (WP540)
- EAMNet will undertake user consultation and engagement in the implementation and operation of the Lisbon Process on *GMES and Africa* (WP600, M11)

3 Description of the main S&T results/foregrounds

The description of the EAMNet results below is split according to the four objectives of the project, which map to work packages 200, 300, 400 and 600 with dissemination activities described at the end of the report. The reader is reminded that, as a Coordination and Support Action (CSA) EAMNet did not undertake any science and technological research per se.

The way that the objectives (and the work packages) fit together conceptually is shown in Figure 1 which visualises the “continuum” of activities to support capacity development and maintenance. It was envisaged that a variety of activities were needed to address postgraduate students, early career researchers and even mid-career scientists and these were carried out during EAMNet.

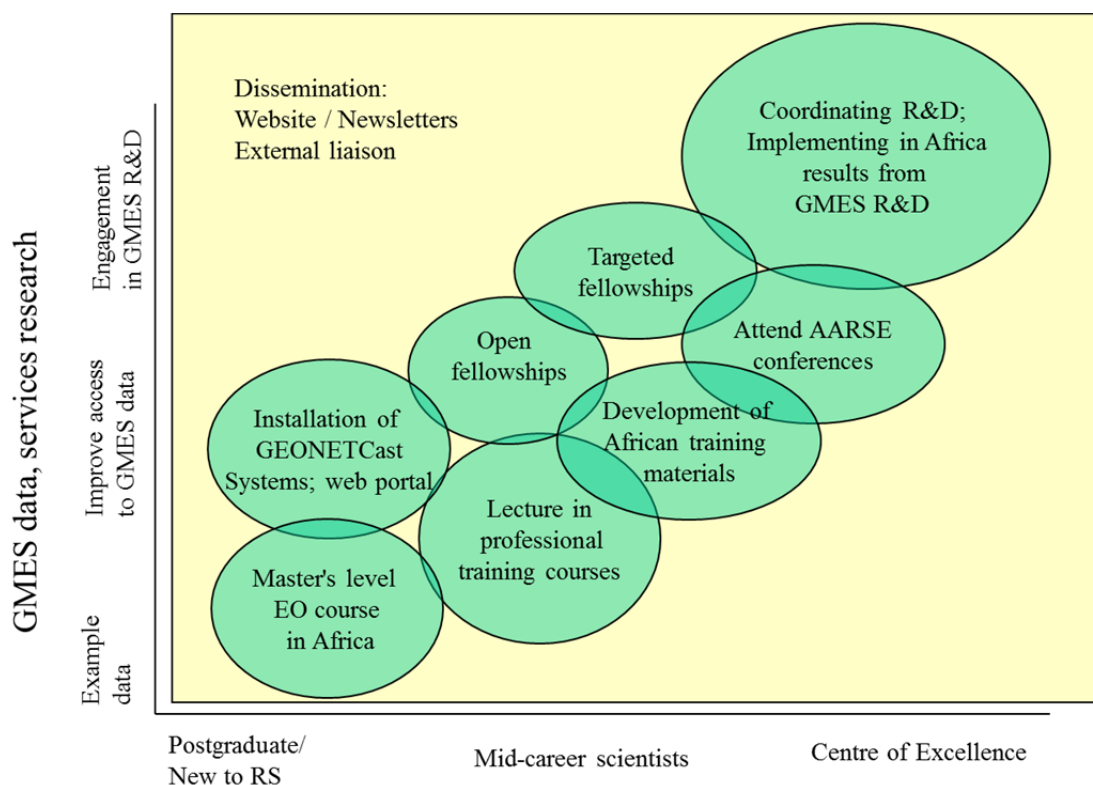


Figure 1: Updated development “continuum”

3.1 Objective 1: To improve access to marine EO data, increase data exchange and encourage increased use of EO

The first activity was to increase the data available to African marine scientists and improve the modes of access.

3.1.1 EO requirements and data availability

At the start of EAMNet a survey was undertaken to review existing and planned marine training structures, tools and expertise in order to assess additional training requirements to meet the GOOS-Africa strategy. The survey also sought input on the types of data that were required for African research users. This is shown in *Figure 2* : although all data types were requested by over 50% of respondents, SST and chlorophyll-a data were the most popular, reflecting their use in activities such as fisheries management of high socioeconomic importance in Africa.

Starting with the user survey and also the outputs from the earlier FP7 DevCoCast project (GEONETCast for and by developing countries) a review was undertaken of the data available for Africa from a variety of sources. The main data providers were: the EC FP7 MyOcean the GMES marine core service, that provides data for a number of European regions and globally; the Eumetsat Ocean and Sea-Ice Satellite Application Facility (OSI_SAF) that provides a wide variety of meteorological and oceanographic data that are broadcast via the EUMETCast/GEONETCast service; and the DevCoCast project. The review of the available data resulted in additional data processing for Africa described below.

The results were published as a report giving detailed technical information on the data available. However, although the form of the review was well received it was too complex for the majority of users and potential users of GMES EO data in Africa. Instead, a web-based catalogue of EO data of relevance to EO users in Africa that contains the bulk of the data review information was produced (see http://www.eamnet.eu/data_portal/catalogue; Figure 2b). It includes example imagery and access to data produced by EAMNet, MyOcean, and OSI-SAF. As was recognised in the initial report, data processing systems, data types and data formats will evolve with time: the website provides a simple method to present and disseminate this kind of changing content and will be updated on an ad-hoc basis.

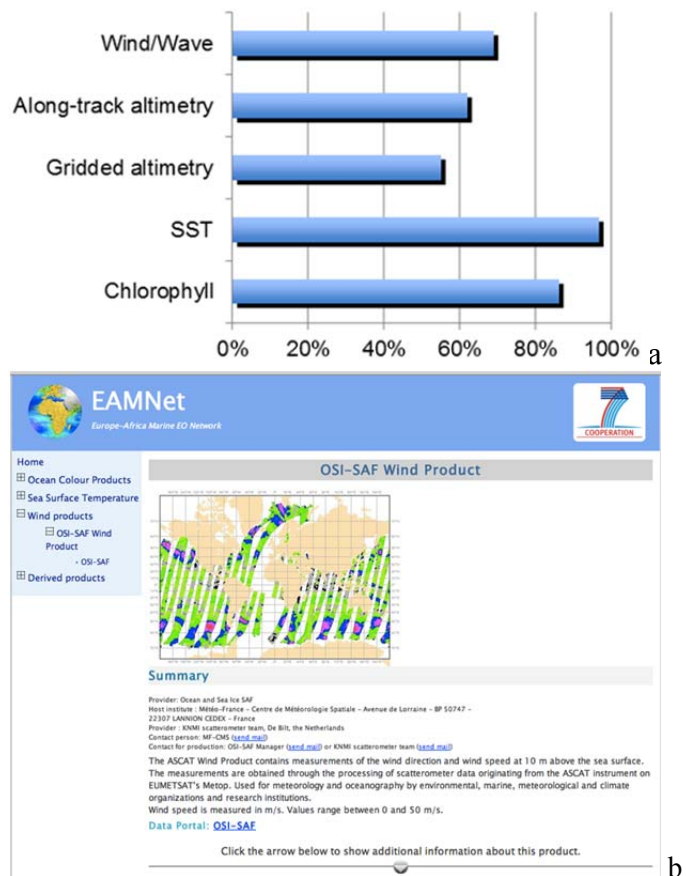


Figure 2. a) Requested data from EAMNet ; b) data catalogue listing MyOcean, OSI-SAF and EAMNet data

EAMNet EO data production and distribution

Following the reviews of data needs and data availability it became clear that there were gaps in data provision over Africa. Notably, high resolution (1-km) sea-surface temperature (SST) and ocean colour were only available for some regions (such as the Mediterranean Sea through MyOcean) and in selected areas on the Atlantic and Indian Ocean coasts (from DevCoCast). Hence, EAMNet aimed to fill these gaps by producing near-real time and delayed mode (or refined) SST and ocean colour products or the regions shown in Figure 3a from mid July 2010. Subsequently, archived data were processed to provide a complete time series from the start of EAMNet.

Ocean colour products included Chlorophyll-a, attenuation coefficient at 490nm (K_d490) and water leaving remote sensing reflectance at 551nm (a proxy for suspended particulate matter) were produced from the NASA Moderate Resolution Imaging Spectrometer (MODIS) on the Aqua spacecraft. Chlorophyll-a using case 1 and case 2 algorithms, yellow substance, suspended particulate matter, and false colour composites were also produced from the ESA Medium Resolution Imaging Spectrometer (MERIS) until contact was lost with the spacecraft in April 2012. The data archive will be updated after the next NASA ocean colour reprocessing due later this year. All areas were produced by PML and, additionally, those in the south by UCT.

Ocean colour data production followed pre-existing methods and guidelines from DevCoCast for consistency. Production at PML followed the MyOcean system, which was updated as the MyOcean system developed. To be clear, the PML EAMNet processing utilised the same *system* as MyOcean but produced distinct and complementary data products. These data *complemented* the lower resolution SST and ocean colour data and the sea-level data already disseminated via GEONETCast provided by OSI-SAF. These data also complemented the lower resolution global data produced in MyOcean.

Compared to the DevCoCast project there were 10 additional regions and each day 13 products were produced. Initially the data processing complemented DevCoCast (i.e. EAMNet produced an extra 10 regions) but in the final year of the project (after completion of DevCoCast) EAMNet took over the processing of all areas over Africa.

Following a presentation by PML at the “Workshop on operational product availability for users in Africa” 27-28 August 2009 at Eumetsat, Darmstadt, the African Monitoring for Environment and Sustainable Development (AMESD) project became aware of the activities at PML in the MyOcean project and in DevCoCast. At the start of EAMNet the AMESD Marine and Coastal Thema, through the Mauritius Oceanographic Institute (MOI), requested ocean colour coverage of the Indian Ocean region to the east of Africa using the same procedures as EAMNet. These areas were set up in addition to the EAMNet areas and are currently available via the web portal. It is believed that the additional data volume should be within the bandwidth purchased through EAMNet. If not then Eumetsat and AMESD agreed to find ways of covering any additional costs.

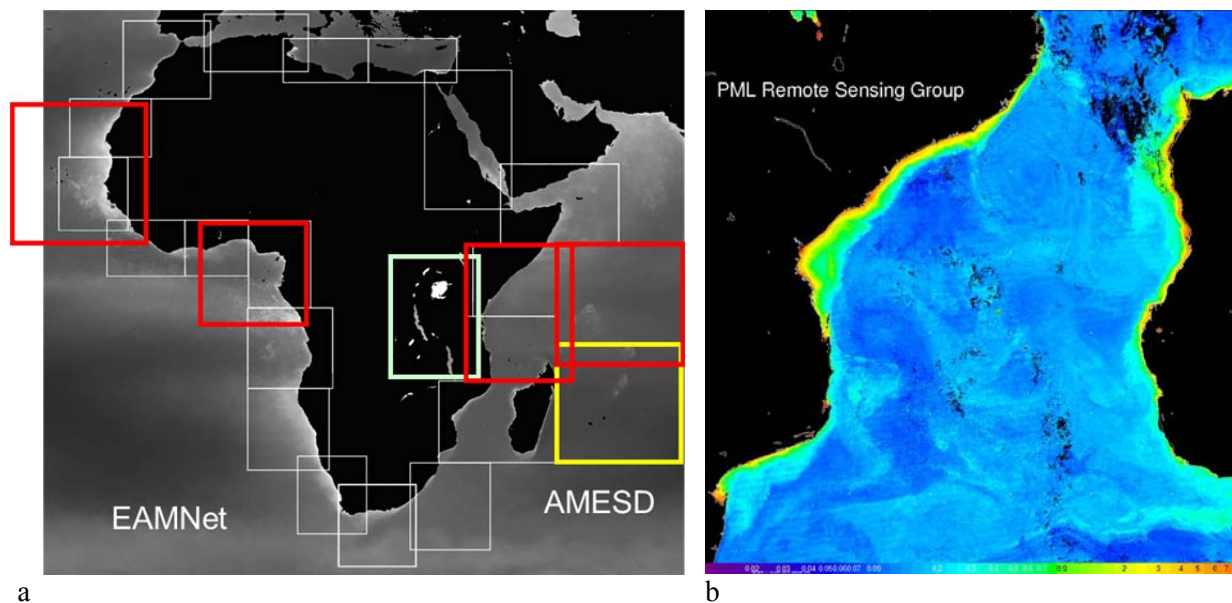


Figure 3. a) EAMNet high resolution coverage; b) example chlorophyll-a- MODIS composite of the Mozambique channel.

The extended coverage provided through EAMNet gives complete coverage of ~1-km resolution ocean colour and SST data over the African coast. In collaboration with AMESD, the EAMNet project has produced additional areas covering parts of the Indian Ocean of relevance to the AMESD Marine and Coastal Thema. These data are available via the EAMNet data portal and will shortly be available via GEONETCast and complement lower resolution data available via GEONETCast through the Eumetsat OSI-SAF and lower resolution data from MyOcean. The data provided the “raw material” for exploitation by the fellowships and training programmes in EAMNet.

Data provider contact information is as follows

PML

- Data manager contact: info@neodaas.ac.uk
- Portal URL: <http://www.neodaas.ac.uk/multiview>

UCT

- Data manager contact: Stewart Bernard
- Portal URL: <http://www.chlorogin-africa.org.za/mrsu/php/dataSearch.php>

Non-EAMNet data provider of global/continental scale data are

- MyOcean: <http://www.myocean.eu/web/24-catalogue.php>
- OSI-SAF: http://www.osi-saf.org/visiteurs/produits/produits.php?safosi_session_id=c8bb8a23219eecbbfc6e7831f9ee22dc

EO data distribution

EAMNet planned two routes of data dissemination: the GEONETCast system that uses Digital Video Broadcast and the internet via web-portal.

GEONETCast Distribution

GEONETCast is a data distribution system that uses commercial satellite to broadcast data via Digital Video Broadcast (DVB) to Africa and elsewhere around the world. The GEONETCast infrastructure in Africa has been built-up over a number of years through projects such as PUMA and AMESD but initially had limited coverage to the marine community. DevCoCast helped this by installing five low-cost receiving GNC stations and EAMNet attempted to emulate this (and this is described below).

In order to use GNC to distribute EAMNet data a number of steps were undertaken. First, since GEONETCast delivers thousands of files per day, in order for end users to cope with this number of files, products followed a naming convention that allows for inclusion or exclusion by simple text matching. Users will want to organize the files they receive according to source, the time period or area that they cover and/or the type of content. It is useful if they can do all that, just by using proper elements from the file name. So EAMNet prepared a document describing this and other requirements. Second, GEONETCast distribution utilised the existing marine hub established at PML (in the DevCoCast project) to monitor all data transfers to EUMETSAT who monitor operations of the GNC system. Finally, tools were provided to utilise the data (see below).

EAMNet Data Portal

The EAMNet Data Portal (http://www.eamnet.eu/data_portal) was set up to provide a central web site point of access to the datasets supplied by EAMNet partners PML and UCT for Africa. It complements the GEONETCast delivery for those users with an acceptable internet connection. It appeared on 29th May 2010 and has been updated with new information periodically. It also provides access to data provided by other producers such as the EC Joint Research Centre and NASA.

Originally it had been planned to build on the data portal in the ChloroGIN web site (www.chlorogin.org and www.chlorogin.org/africa): instead a more flexible, new portal was produced that uses the open source OpenLayers library [OL10] to display the base map of Africa and the bounding boxes of the various areas of data supplied by partners. The definitions of these areas are accessed using the OGC WFS protocol [WFS] from a server hosted by PML. Using open source software and standards allows the geographic area of the map to be updated easily and provides simple methods to add remove and update the definitions of the data areas. This contrasts with the ChloroGIN portal which uses fixed ranges for geographical areas, and is therefore more difficult to update, and cannot be zoomed or panned to focus in a given region.

The EAMNet Data Portal (see Figure 4**Error! Reference source not found.**) was themed to match the “look and feel” of the main EAMNet website and may be accessed via the front page. It provides a graphical user interface showing the geographical area covered by the datasets on the left; once a point is selected (clicked) on the map a list of datasets covering the selected location is shown on the right.

If a more detailed view of an area is required the map may be zoomed using the + / - buttons at the top left (or the mouse scroll wheel) and panned using the arrow buttons immediately above (or with a mouse drag).

The datasets were provided through the partners' own web portals: this follows the ChloroGIN concept of preserving the regional identity of data providers, so that individual “centres of excellence” are recognised, and enables local preferences to be retained. Other data sets, such as from NASA and JRC, are also accessible. The partners’ portals are accessed by clicking the colour coded “View” link on the right which will open a new window. This has the advantage that additional data providers can be easily added such as the European Space Agency, Ocean Colour Climate Change Initiative data set that was added in summer 2013. In the case of PML, which has an access control system to record usage, the user is logged-in as a “guest” user; with UCT open access is available.

Select your area of interest by clicking on the map. Available datasets will be highlighted and displayed in the list on the right. View the dataset by clicking on the colour coded "View" link (the dataset will be opened in the provider's own portal).

AVAILABLE AREAS						
name	provider	north	south	east	west	link
AMIS	JRC	40.0	-50.0	60.0	-30.0	View
Cape Verde Large 4km	PML	40.0	0.0	20.0	-30.0	View
EAMNet: Mauritania	PML	16.0	10.0	-14.0	-24.0	View
Mauritania	UCT	16.0	10.0	-14.0	-24.0	View

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Figure 4. EAMNet Data Portal

Multiple datasets are often available for a specific location; such as the Nigeria area, supplied by both PML and UCT (Figure 5).

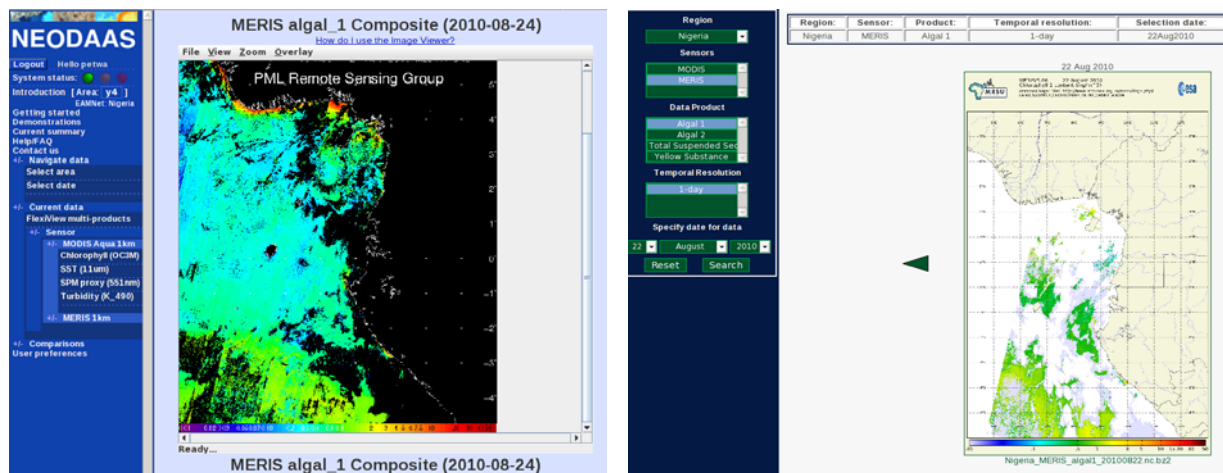


Figure 5. Example Chlorophyll images from PML (left) and UCT (right) portals.

Results

For the duration of the project high resolution 1-km data were produced on ocean colour and sea-surface temperature by PML and UCT. However, during the project a number of satellite systems failed including the SeaWiFS and MERIS sensors (in Dec 2010 and Apr 2012, respectively) limiting the range of sensors available. Data production has continued beyond the end of EAMNet on account of the interest from partners and also direct requests from the AMESD/MESA project.

The GEONETCast distribution proved to be a success, and the data have been used regularly by the EAMNet partnership and also scientists engaged in the AMESD and successor MESA projects. Eumetsat have agreed to continue the data transmissions to Africa. Likewise the data portal was operational throughout the project and continues to provide data. The development of the portal has given a particularly strong presence of Africa in the ChloroGIN portal: Africa is the only continent for which high resolution data for the entire coast are available on ChloroGIN.

3.1.2 GEONETCast system installation

As noted a key EAMNet aim was to extend the marine environmental EO user base in Africa by installing additional GEONETCast receivers at African Universities and marine research institutions. These new receiving stations would complement the small extant network of GEONETCast stations by extending the user base into the Mediterranean and countries with no existing marine community systems. The original work plan aimed to install new very low cost systems (~€4k) at five sites around Africa. An important aspect of the receiving station installation method proposed was the avoidance of using only European or South African technical expertise for station installation. This was because, reliance on imported installation expertise is costly and does little to foster local ability to maintain infrastructure. Experience with DevCoCast showed that the above approach of hardware provision and constrained local installation involvement minimised cost and user activation barriers, used available local expertise where possible (considered best practice for on-going antenna maintenance), and reduced risk by reducing dependency on local commercial operators to antenna installation and alignment only. Contingency for the use of external professional South African technicians was made where necessary where no suitable local operators could be utilised.

Results

The original plan was to install the five systems in Cote d'Ivoire, Tunisia, Egypt, Benin and Mozambique. The process of contacting users for receiving station installation started in August 2010. There were many delays in receiving confirmation of the installation process from users and proper

communications with the majority of users was only established after the intervention of the IOC/GOOS-Africa project office in December 2010. Indeed, no response was received from the Institut National des Sciences et Technologies de la Mer in Tunis despite numerous interventions, and the decision was taken to replace this user with Makerere University in Uganda as of May 2011 (with a user focus on Lake Victoria). Hence, the final list of system installations was:

- Université de Cocody Abidjan, CURAT, Abidjan, Cote d'Ivoire
- Makerere University, Uganda
- National Institute of Oceanography & Fisheries, Alexandria, Egypt
- University of Abomey-Calavi, Cotonou, Benin
- Eduardo Mondlane Universidade, Maputo, Mozambique

In June 2011 a two-day technical training session was conducted at UCT, attended by seven EAMNet users, in conjunction with the Operational Oceanography school. Antenna installation kits (prepared in South Africa) and computer workstations for data reception and analysis were shipped to users, who received them at their institutes from August 2010 to February 2011, with many delays due to customs, clearance fees and local bureaucracy. The equipment supplied consisted of those found to work in the DevCoCast project (with the exception of the Windows 7 operating system)

By April 2011 delivery of all station hardware was completed; however, most stations were still not installed due to delays in permissions to install, institutional closures due to civil unrest, paying foreign installation costs with South African Reserve Bank restrictions, and some ineffective communication from users. Installation of the receiving station hardware was conducted by users over the next six - eight months, where upon it was established by consensus that all users were experiencing similar problems: the Technotrend DVB cards would not operate under the Windows 7 environment. A further troubleshooting survey was sent out to all users in May 2012 to establish the exact status of the antenna installation, correct antenna alignment, transponder status, DVB card function, reception signal status, and ECU activation.

The UCT GEONETCast receiving station was reconfigured to mirror the new systems that had been shipped to users, and it was found that the Technotrend DVB cards had no available drivers for Windows 7 and could therefore be considered obsolete. In addition it was found that the majority of users had not aligned their antenna correctly. New DVB cards, compatible with Windows 7, were supplied to all users during November/December 2012 and installed over the next few months. During this period, major storm damage was reported for the Mozambique antenna system and twice for the Egyptian antenna system. The Egyptian system was repaired & active within several weeks of each event through the use of locally sourced and installed replacement dishes. During January – May 2013 the receiving stations in Benin, Cote d'Ivoire, and Uganda came online after (in some cases repeatedly) addressing antenna orientation, licensing and hardware issues.

Currently, all stations are operational with regard to reception other than the system in Mozambique, which will shortly have a dedicated site visit by South African engineers to locate a new installation location and install a solid 2.4m diameter antenna.

Conclusions and links with other work packages

The provision of low cost receiving stations is central to EAMNet aims and represents a potentially high-impact solution to significantly improve the ability of African marine scientists to access the data they need at a low cost. The installation of five new receiving stations, complementing the existing DevCoCast stations in Senegal, Ghana, Namibia and Tanzania, now provides a coherent Pan-African data provision network.

The GEONETCast receiver network will allow African scientists to maintain easy and continuous access to data. In addition, the low-cost model used by EAMNet has also resulted in considerable gains in expertise with regard to the installation and maintenance of receiving stations based on

commonly available commercial components and existing, wide spread commercial satellite TV expertise. Such a gain in expertise is arguably one of the most important components in establishing a sustainable African capability to fully exploit marine Earth observation data.

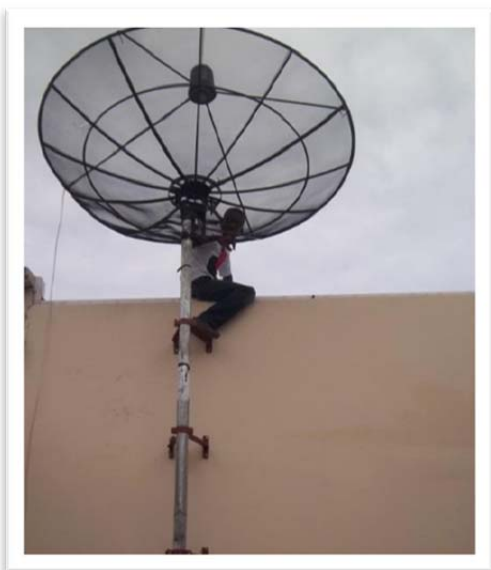
However, the very low-cost, user self-install GEONETCast receiving station model employed by the project was shown to have some disadvantages, primarily that technical challenges cannot be dealt with rapidly. But the model provides the lowest entry point to receiving data through GEONETCast. A full list of advantages and disadvantages of this approach is provided in D230.1. Recommendations, intended to improve upon the low cost model for future implementation, are listed below (further detail is available in D230.1).

- An installation model, using low cost hardware but with a dedicated expert site visit for install & training would be slightly more expensive but is likely to be more effective and result in quicker installation and avoidance of first order technical glitches.
- On-going compatibility checks are needed to ensure working DVB variants for commonly used operating systems, with spares in hand.
- Very low cost mesh dishes are not suitable for high erosion coastal environments, although biennial replacement of semi-expendable dishes a possible budget option – dependent on site specifics. Similar setups in GMES and Africa should consider the nature of the marine and coastal stations before considering very low cost but less rugged dishes.
- One off technical training (as with other types of training) has limited impact. On-going training with refresher sessions, technical updates, auto-didactic technical material will empower less technically adept users. The ILWIS software supplied to users was reported by several users as being difficult to use and non-intuitive – simpler systems for first order visualization of received and archived station data should be investigated.

Ensuring longer term operation of the receiving stations post-EAMNet is important, specifically in the context of GMES-Africa services. This is made more difficult without explicit funding, but the potential maintenance costs are small and can probably be borne by host institutions if the stations are perceived to be valuable enough. The following recommendations should maximize chances of survivability:

- Continuation of data provision and adaptation of the dishes for new Sentinel-based data channels as they come online. Enabling users to access data routinely and easily is the single biggest motivator for sustainability. PML and UCT as core EAMNet data providers will continue to distribute data through GEONETCast, and UCT will continue to provide assistance to users with regard to station configuration, testing etc.
- The most likely hardware components requiring routine replacement are the external dishes (storm & weather damage) and the DVB cards (upgrades to operating systems or to DVB-S broadcast). These components are relatively low cost and there is some chance their costs could be covered by host institutions, although it is recommended that GMES-Africa or MESA make a small contingency fund available to allow replacement of low cost components for existing receiving station hosts.

a



b



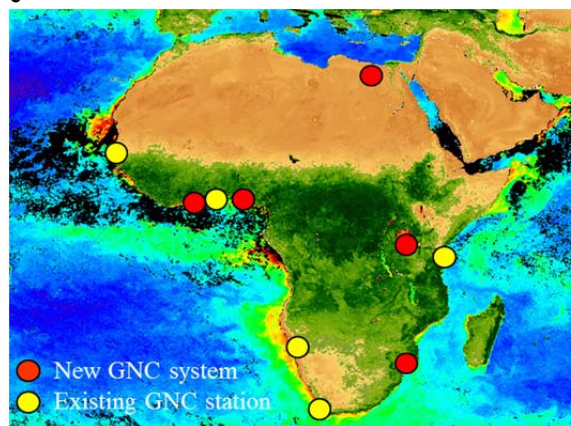
c



d



e



f



Figure 6. EAMNet GEONETCast dishes: a) Cote d'Ivoire; b) first Egyptian dish destroyed by high winds; c) Mozambique dish severely damaged by wind; d) Benin dish; e) marine GNC network; f) University of Makerere student stood in front of receiving dish, Uganda.

3.1.3 Tools

Recognising that African institutions cannot usually afford to spend scarce resources on commercial software, EAMNet aimed to ensure that data disseminated through the project was accompanied by appropriate processing software, and that support was provided to allow users to effectively install and use these tools, thus allowing users to utilize EAMNet data in their activities. The tools provided through EAMNet were therefore accompanied by tutorials, which demonstrate key utilities, using examples from African case studies, wherever possible. All tools disseminated by the project are open source or free (available at no charge).

Deliverable 250.2 outlines recommendations for how best to provide suitable processing and analysis tools to meet the requirements of EAMNet's African partners and their associates, and outlines the software upgrades and tutorial development necessary to achieve this. It also discusses the support that is required to ensure that both tools and data are used appropriately, what support EAMNet should provide for the different tools, and how to integrate this support with other project activities such as training (WP300), fellowships (WP400) and the EAMNet website (WP510). The recommendations are based on a survey of data processing and training needs of EAMNet African partners and their associates and a review of the capability of existing software and tutorials to meet the requirements highlighted in this survey.

Results of user requirements survey

A tools and training survey of African partners was undertaken in July/August 2010. Results revealed some general trends that were used to guide the development of image display and processing tools, the development of tutorials, and the planning of associated training activities. Discussion also took place at the EAMNet kick-off meeting on requirements and developments needed for the tools. Key findings and their implication for the development and provision of processing tools are given below.

Research and development was a key activity for all participants in the user survey. Two thirds of the respondents planned to use EAMNet data in their own education and training activities. About 3/4 of the respondents will use the data to support environmental management work, and a similar number are expecting to undertake operational monitoring. About half have plans to combine the data with forecasting/prediction. Primary productivity studies, water quality assessments, and fisheries are key application areas for the vast majority (~80%) of users. This is closely followed by studies to monitor the distribution and health of different habitat types. Sea level, coastal erosion and sediment transport are also important application areas, relevant to over 2/3 of users. This informed the development of the core processing tools to ensure they supported these user activities; while, where possible, case studies chosen for supporting tutorials reflected the main application areas of interest.

The use of data types is shown above in Figure 2 a. This feedback provided valuable insight into the requirements of potential users which informed the development of tools within the project. Key points identified were:

- Virtually all users plan to use EAMNet ocean colour and SST data
- 2/3 of users plan to use along-track (coastal) altimetry and wind/wave data.
- Over 3/4 of the respondents require hands-on tools for image manipulation and display.
- A significant proportion will need to be able to use the images with GIS tools
- About 2/3 of users require tools for time series analysis and statistical analysis, such as EOF (principal components).
- Just under half of the users surveyed require classification routines for use in habitat monitoring.
- More specialised tools, such as routines for front detection or regional algorithm development, are required by a minority of users (all with high levels of expertise).
- The vast majority (90%) of users anticipated having to do batch processing of large data volumes, in keeping with their plans to carry out monitoring and forecasting/prediction activities. There is, thus, a clear need for programmes or scripts that can automate the processing of EAMNet data, particularly in the application areas of interest to the majority of users.

- All respondents stated that they use Windows as their main operating system so any software and other processing tools provided in EAMNet must therefore be capable of operating in a Windows environment

Half the respondents to the survey had little (30%) or no (20%) experience of remote sensing data; only three of the respondents considered themselves expert users. The level of programming skill is generally low; almost half the respondents reported having no computer programming experience, and a further quarter have only limited experience with programming or scripting languages. Of the remainder, only one classed himself as an expert. These findings have important implications both for the supply of different processing tools, and for the degree of support that will be required in terms of documentation, tutorials and direct, personal tuition. Core tools, such as Bilko, which will be supplied as 'distance learning' resources must be supported by detailed tutorials using examples that cover the main application areas for which EAMNet data will be used. Given the lack of programming expertise, it was presumed unlikely that scripting tools supplied would be widely used, without personal tuition and support being available.

EAMNet processing and analysis tools

The processing and analysis tools provided for use with EAMNet data fell into three broad categories:

- (i) Core tools provided to users via the website and (if possible) through the GEONETCast Training Channel. These include: UNESCO-Bilko software and tutorials capable of reading, displaying and processing gridded EAMNet data; BRAT (Basic Radar Altimetry Toolbox) for the display of along-track altimetry data, and the GEONETCast Toolbox, developed as a plug-in to the ILWIS version 3.6 software to facilitate the import satellite and environmental data into a common GIS environment.
- (ii) Scripting tools for carrying out key processing tasks that are repeatedly performed by EAMNet users, and
- (iii) Specialist software packages that were reviewed by EAMNet, and used in some of the training activities. The packages including BEAM, SeaDAS, open-source GIS software (e.g. ILWIS), open-source versions of programming packages (e.g. Octave – a Matlab clone) and Python were used by at least some of the partners, but were not specifically supported by documentation and tutorials developed in the project.

The training survey also resulted in a list of detailed recommendations on changes and improvements to the tools proposed; space precludes description of the existing tools and the reader is pointed to Deliverable D250.2 "Tools Update. Herein focus is given to the new tools and lessons developed

3.1.4 Software developments

Whilst the emphasis was on developing routines and tutorials showing how to use different software to analyse EAMNet data, some software development also took place in collaboration with Bilko Development Limited (BDL) who develop the Bilko software for UNESCO. Bilko is a complete system for learning and teaching remote sensing image analysis with existing lessons available that complement those developed through EAMNet. Previous lessons developed teach the application of remote sensing to oceanography and coastal management, but Bilko routines may be applied to the analysis of any image in an appropriate format, and include a wide range of standard image processing functions.

In the first 6 months of EAMNet, BDL modified Bilko to read EAMNet data formats, including flags. In consultation with BDL a number of 'mini-programmes' in Bilko's internal programming language were developed to handle selective, user-determined application of flags, compositing of quality-controlled data in time and space, the filling of minor data gaps, application of filters etc. This development went hand in hand with improvements to the Bilko software, to streamline routine processing and analysis tasks performed by EAMNet data users. Bilko output data formats were extended to ensure compatibility with ILWIS, this was an essential update as it ensured that Bilko is

compatible with the GeoNetCast tool box plug-in. In the last 18 months of the project Bilko has been upgraded to allow batch processing. This is still at a basic level at present and further improvements can be made, but this is a significant achievement, which has involved EAMNet partners in setting priorities for Bilko software development, and testing consecutive beta versions of the software. The latest version of Bilko makes it easier for users to process large amounts of data in one go, having first developed their 'mini-programs' in interactive mode. Gap-filling, basic quality control and the application of filters and simple 'mini-programs' for user-developed algorithms can now be applied from batch processing mode.

3.1.5 Development of data analysis tools and supporting tutorials

Tools developed through EAMNet are freely available to download from the Bilko website (<http://www.noc.soton.ac.uk/bilko/index.php>) with links available from the EAMNet project site. Previous lessons developed teach the application of remote sensing to oceanography and coastal management, but Bilko routines may be applied to the analysis of any image in an appropriate format, and include a wide range of standard image processing functions.

As well as annotated lectures from the MSc module, EAMNet have added several hands-on computing exercises to the site as listed below:

- Applying flags to MODIS ocean colour (OC) images: This lesson introduces you the bitwise operators required to extract and apply individual flags to MODIS SST and ocean colour data. The method is general, and may be applied to any data-type with associated 'flag codings' and 'flag bands'.
- Using Analysis SST to clear residual cloud from MODIS SST data: Cloud top temperatures are usually much lower than sea surface temperatures. The presence of undetected sub-pixel cloud may therefore lower the apparent SST in MODIS images. This lesson shows how to use a lower resolution analysis data with the MODIS data to mask pixels that are likely to suffer from such cloud contamination.
- Creating quality-checked weekly composites of MODIS SST: This lesson builds on work carried out in the lesson on clearing residual sub-pixel cloud from MODIS data. It explains how to create lists of files held in the different data directories, and how to edit these in a text editor to create Bilko sets for quality control of multiple images. Once clouds have been masked in the individual data sets, the lesson shows how to merge these into weekly images for further analysis of coral bleaching risk.

3.2 Objective 2: To develop long-term sustainable approaches to capacity building in marine Earth Observation

The overall aim of the training work package (WP300) was to increase the number of skilled scientists, engineers and technicians able to exploit EO data. It recognised that there are different levels of expertise in Africa that have different training needs to be equipped to fully take advantage of the environmental added-value datasets provided through the project as noted above. A range of activities were originally planned to meet these requirements as follows:

1. Review existing marine training structures, tools and expertise and assess additional training requirements in order to meet the GOOS-Africa strategy
2. Extend and build upon existing training courses run by JRC, AMESD, DevCoCast, ASCLME and other organisations to provide training courses for continued professional development; contribute to a regional training course to be run and funded through NF-POGO
3. Design, develop and implement an M.Sc. unit module in marine Earth Observation
4. Implement the EO module in courses at the universities of Cape Town, Ghana and Dar-es-Salaam
5. "Train the trainers" by offering support to participants from other African universities or marine institutes who wish to develop marine EO skills or to incorporate marine EO information and techniques into training activities at their home institutions.

These activities largely proceeded as planned apart from the contribution to existing training courses, where many fewer took place than expected. As a result greater emphasis was placed on the EO module implementations at the four universities which were enhanced to become regional training courses. Coupled with the JRC training course in Morocco which used the EO module, training courses were given in north, south, east and west Africa.

3.2.1 Results of training needs survey

The tools and training survey, mentioned above, returned very useful data to assist in the organisation, planning and key focal areas of Pan-African marine Earth observation related training activities. A summary of the key implications for training efforts, based on the survey results, are presented in Figure 7 a,b and summarised below

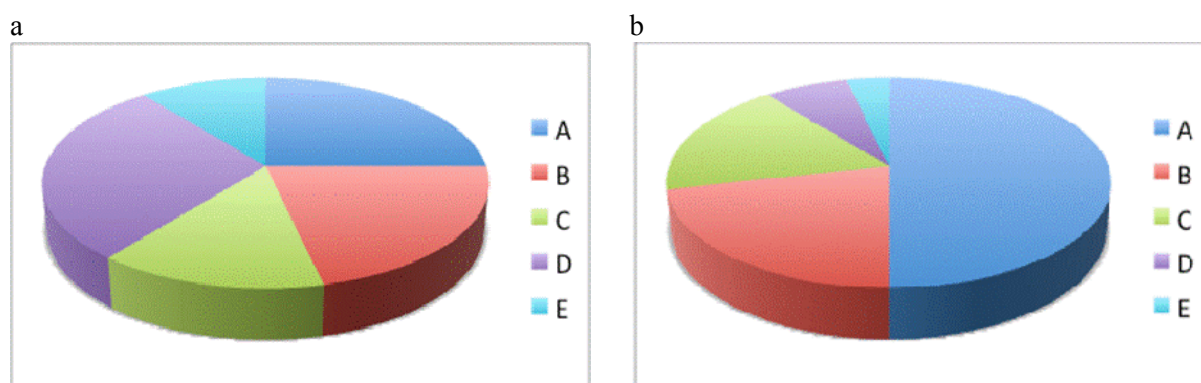


Figure 7. Training needs: a) Remote sensing; b) computer programming. A=no experience; E=expert user

- Training in remote sensing techniques was considered "extremely important" by the vast majority of respondents ranging from marine professionals, post-graduate students and technicians. Yet, half the respondents had little (30%) or no (20%) experience of remote sensing data; only three respondents consider themselves expert users.
- The lack of programming skills was even more marked with almost 50% having no experience; furthermore, almost all respondents only used MS Windows as an operating system – an implicit

indication of a lack of IT and programming capabilities. Despite this, the large majority of respondents wished to undertake batch processing of data – which typically requires some programming capability. Additionally, approximately 75% of respondents wish to use data to support environmental management work, a similar number expect to undertake operational monitoring, and ~50% have plans to combine EO data with forecasting/prediction. All these activities will require a greater technical capability than currently appears to be available.

- With regard to formalised institutional training in marine Earth observation, only four institutes are currently running routine EO postgraduate course components at an Honours, M.Sc. or higher level:
 - University of Cape Town (UCT),
 - Eduardo Mondlane Universidade (EMU) in Maputo, Mozambique (with a major portion of the curriculum and teaching carried out by UCT),
 - University of Ghana (UG), and
 - University of Abomey-Calavi (UAC) in Cotonou, Benin.
 - The University of Dar es Salaam (UDSM) runs biennial M.Sc. courses with a small EO component. Several other institutes offer courses in marine or aquatic sciences with environmental data/GIS content, or offer occasional training focused on these fields. An approximate annual estimate of the number of taught M.Sc. students receiving institutional Earth observation training is put at ~25 across the continent, although Earth observation may not be the major or only focal area of the specific M.Sc. course.
- With regard to application areas and the type of data that will be offered through EAMNet, there are training gaps concerning some of the application areas/data types, most notably with regard to altimetry and synthetic aperture radar (SAR) derived products. Training with regard to the uses of ocean colour and sea surface temperature is generally available through postgraduate or short courses e.g. primary productivity studies, water quality assessments, and fisheries. Some training on habitat monitoring/mapping, coastal erosion and sediment transport is offered, primarily through the JRC-led African Ocean Colour course using medium resolution data. There is currently little routine or short course training on using high resolution data for these applications and communication with terrestrial programmes should be improved in this regard, as these near-shore applications were not considered central to the EAMNet objectives. However, only UCT and EMU offer postgraduate course components in altimetry and synthetic aperture radar theory and applications, and while the AMESD short courses offer introductory material on radar/microwave remote sensing, these are currently not detailed enough to facilitate application in complex and dynamic coastal ecosystems. Whilst along-track altimetry was identified as desirable, by around two-thirds of survey respondents, there is currently little training in along-track altimetry usage in any format. This is primarily due to the emerging nature of the field, as there have only recently been research activities in the field in Africa. The desire to utilise data and climatologies on sea level variability, currents, tides and waves (observation and forecasting) is stated by between 40 – 70% of respondents. More short-course training in these application areas is needed if relevant EAMNet disseminated data are to be utilised effectively.

3.2.2 Contribution to existing training courses

At the start of the project a number of courses were identified in which EAMNet could make a contribution. In particular, the Nippon-Foundation/POGO course was to be a major activity in EAMNet: however, the POGO support eventually was not forthcoming and a number of other courses did not take place or were not appropriate for an EAMNet contribution. Hence, the scope of the regional training courses was modified as explained below in section 3.2.6.

3.2.3 Module development

The EAMNet EO module course structure was developed based on the following input:

- assessment of existing M.Sc. modules and short courses taught in Africa (D310.1);
- survey of user training needs for African marine Earth observation (D250.1);

- analysis of existing and emerging strategic initiatives in African marine EO, primarily through GOOS-Africa, GMES-Africa draft strategy, GEO initiatives, and national and regional strategic initiatives such as the OceanSAfrica Operational Oceanography initiative;
- consultation with EAMNet partners and externally aligned groups, specifically those involved in M.Sc. and other regional training initiatives: UCT, UG, UDSM, NOCS, JRC, AMESD.

The review of course material for the M.Sc. unit curriculum from the perspective of the user needs survey (D250.1) revealed that African users are primarily interested in ecosystem type studies, e.g. ecosystem productivity, fisheries applications and water quality assessments. Coastal issues such as sea level change and sediment transport were also important to users, as were forecasting and prediction. User applications, taken from a strategic perspective, again highlighted the need for training in multi-sensor Earth observation, giving users the ability to observe physical system drivers and biogeochemical system response.

Regarding remote sensing disciplines, the required training in ocean colour and sea surface temperature (SST) applications is already well established in South Africa, but experience in the Joint Research Centre of the EC (JRC) and Delphe courses have indicated that, although EO data are used extensively for terrestrial applications, training in marine EO data analysis and application does not appear to be well-established at other African Universities. Most of the training in marine EO applications received by African students occurs during postgraduate studies through international exchange (African or other) and self-training. The existing UCT M.Sc. curriculum utilizes some African examples from the BILKO Envisat module and it is possible to create more considering the increased access to data. User needs and broader strategic initiatives highlight the need for greater depth of training in the use of both gridded and along-track altimetry, and other means of obtaining wind/wave data, such as scatterometry and synthetic aperture radar (SAR). There is also a strong requirement for tools for image manipulation and display, tools for time series analysis and statistical analysis, and specialised tools, such as routines for front detection or regional algorithm development. Although BILKO addresses some of these needs quite competently as an introductory tool, it is not yet efficient when manipulating large amounts of data. This need could be addressed by developing a MATLAB or Python toolbox, using some of the existing routines and functions, but structuring/grouping the functions in such a way that it facilitates easy spatial data statistical analysis. The new M.Sc. course structure was developed to have components in place to meet most of these needs, either through new or more detailed scientific modules or the provision of training with new processing software components.

Course Structure and Content

The course structure was designed to be highly modular, allowing the module to be taught over a period of a month as “long and skinny, or to be delivered over a shorter, more intense period of at least eight days as a “short and fat” course. The modular nature allowed components to be easily extracted for use in short courses (such as in EAMNet WP 320) and for development of autodidactic training materials or as part of courses run at other African universities (WP360).

The primary course module consists of four thematically clustered sessions with lectures presenting theory, sensor specific understanding and scientific application, and associated laboratory sessions demonstrating the practical application of this knowledge to example African ecosystems or dynamic phenomena.

Sessions, of 3 hours each, were developed to breakdown the following 4 themes covered by the course:

- Introduction to Marine Remote Sensing and Data Processing
- Infra-red, Microwave and Visible Wavelength Passive Remote Sensing
- Active Microwave Remote Sensing
- Sensor Specific Data Processing, Product Analysis and Application

3.2.4 Initial implementation

During July 2009, a regional marine workshop was convened in Cape Town to address the urgent need for a southern African operational oceanography strategy. The major outcome of this workshop was a commitment from marine stakeholders in the academic and government sectors of South Africa to the OceanSAfrica initiative. OceanSAfrica seeks to make the knowledge and capabilities of the marine science community useful to society by providing information on the current and future state of the oceans, and marine ecosystems around southern Africa.

A regional training workshop was offered at the University of Cape Town in June/July 2011 to introduce marine stakeholders, including professionals and postgraduate students, to key concepts within marine EO and hydrodynamic modelling which will enable participants to analyse and interpret output products from these two disciplines in an insightful manner. EAMNet participation in this regional workshop presented a first opportunity to demonstrate the versatility of the course material developed for the EAMNet MSc EO module. Various lectures and practical sessions from the MSc module were easily incorporated into the workshop structure of morning lectures followed by afternoon practicals. It was also possible to minimize the time demand on the work schedules of nominated EO trainers at the universities of Dar-Es-Salaam and Ghana so that they had the option of only attending the first week of the workshop, which covered EO material exclusively. First-hand experience gained by participating postgraduate students and professionals from partner African EAMNet institutions served as valuable preparation for their role as facilitators in the implementation of the EAMNet EO MSc module at their local universities (WP350).

As noted above EAMNet had an aim of supporting existing training courses and specifically a planned POGO (Partnership for Observation of the Global Ocean) sponsored regional training course in Africa. In the planning phase of the course POGO indicated that support would be available; however, ultimately, POGO funding was not forthcoming. Instead, funding was provided from other sources such as the Nansen-Tutu centre. This additional funding meant that some additional activities were possible in support of EAMNet, notably training of trainers.

EO module implementation within the workshop

The African Operational Oceanography Workshop aimed at providing theoretical background and analytical skills in Earth Observation, hydrodynamic modelling and data analysis techniques. Within a three week period participants were presented with a series of lectures and practical sessions that were designed to improve their marine research capabilities to the benefit of home institutions in various parts of Africa.

Topics included in the EO module introduced the concepts of measuring SST, ocean colour, ocean currents, oceanic wind regimes and ocean waves from remotely sensed satellite observations in the oceans around southern Africa. Practical sessions allowed participants to use appropriate software to process and analyse satellite data sets at different levels of maturity. Where appropriate the combined use of *in situ* data with EO data was addressed to emphasize the importance of calibration and validation of observed geophysical parameters or ocean phenomena. The Ocean Modelling module provided a short introduction to the theoretical background and numerical methods of ocean modelling techniques. Several ways in which hydrodynamic models can be used to improve our understanding of ocean processes were introduced through the practical implementation of the Regional Ocean Modelling System. These practical sessions were designed to provide participants with the ability to confidently set up and run their own model simulations. During the final week various data analysis methods were used to identify and interpret variability in ocean processes present in very large satellite and model-derived data sets.

Applicants to the course were required to have an academic background that demonstrated the necessary proficiency in mathematics, physics and Matlab programming to cope with the advanced topics introduced during the three modules (Earth Observation, Ocean Modelling and Data Analysis).

The workshop attracted twenty-eight trainees (seven females) from fourteen institutes across nine different African countries. Represented countries included:

1. South Africa (10)
2. Mozambique (5)
3. Uganda (2)
4. Egypt (1)
5. Ghana (2), including 1 trainer
6. Tanzania (5), including 1 trainer
7. Kenya (1)
8. Benin (1)
9. Côte d'Ivoire (1).

Various specializations were represented by the course participants. Postgraduate students with fisheries backgrounds complemented by applied GIS and remote sensing were attracted. Professionals included several senior lecturers from academic institutions, a marine forecaster, technical officers, marine researchers and a senior marine data base administrator. Training was given in four modules: GEONETCast Receiving Station Operations; Marine Earth Observation; Ocean Modelling; and Data Analysis. Teachers came from various disciplines and institutes, both in Cape Town and abroad:

- Frank Shillington, Christo Whittle, Bjorn Backeberg, Mathieu Rouault, Francois du Fois, Mark Matthews, Fialho Nehama and Andrew Rabagliati (UCT);
- Stewart Bernard and Marjolaine Rouault (Council for Scientific and Industrial Research);
- Pierrick Penven and Steven Herbette (Institute of Research for Development - France);
- Helen Snaith (National Oceanography Centre, UK);
- Johnny Johannessen and Francois Counillon (Nansen Environmental and Remote Sensing Centre, Norway).

Feedback from course participants

Feedback from participants in the various modules was very positive. To gauge the perceived impact and relevance of the EO module, trainees were requested to complete an evaluation form rating the content of each lecture topic, as well as the perceived competence with which it was delivered. The content and clarity of practical sessions were also assessed and course organizers solicited written feedback detailing criticisms and suggestions for possible improvements. Figure 8 illustrates the results from the trainee feedback.

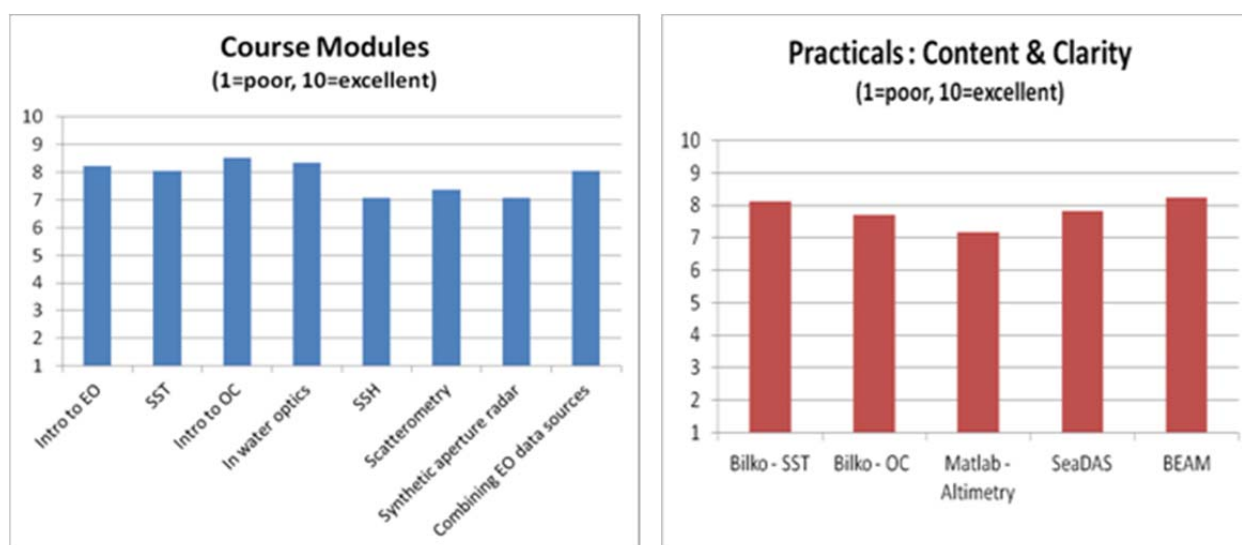


Figure 8. Rating of Course Module Presentation (Blue) and Practical Presentation (Red) by course participants

An approval rating of ~75% was received for lectures and practical presentation. Most of the participants indicated that there was excellent synergy between the theoretical and practical presentations. However, trainees did express a desire for a more generous time allocation during practicals so that they could derive the maximum benefit from the hands-on experience. In contrast, theory time slots were criticized as being "too long" resulting in some difficulty in following the often highly detailed scientific lectures.

Some trainees received their education with French or Portuguese as the primary language of instruction and therefore found it challenging to grasp all aspects of the material, which was presented in English, within the lengthy (60 to 90 minutes) time slots allocated to each lecture. There appeared to be a greater familiarity with the sea surface temperature and chlorophyll-a concentration products and this was reflected in the lecture content ratings. The section on "Combining EO data sources" was also very well received. Some trainees suggested that the availability of lecture materials and recommended journal readings prior to the course would have afforded them the opportunity to be better prepared to follow and understand the concepts presented during lectures and practicals.

Participants were positive about the impact that their attendance at this workshop would have on their academic and professional pursuits, but also suggested the inclusion of material related to climate change, ocean wave height measurement and more online EO data resources.

Conclusions

The versatility of the compiled EAMNet EO MSc module material was successfully demonstrated. It was presented as an independent module using some of the developed material to provide participants in the regional African Operational Oceanography Workshop with an introduction to marine Earth Observation (EO).

In a short course (1 week) there was not enough time to cover the individual topics at an advanced level and this was exacerbated by the diversity of an audience composed of graduates and professionals that are eager to use EO data as a ready tool to assist in solving their particular scientific questions. In this instance the trainees are much more application focussed and less interested in the remote sensing theory underpinning individual geophysical products. During short course implementation, lecture material and practicals should also be adapted to illustrate the relevance of EO data analysis to the anticipated interests of course attendees. Shorter (45 minute) introductory theory presentations should be followed by lectures of similar duration detailing several examples of practical applications from peer reviewed literature for each of the different marine spheres of satellite remote sensing.

Although the course has been well received thus far, there are clear opportunities to improve the course delivery. The lecture material produced at the University Cape Town reflects the regional research interest of the Benguela Current Large Marine Ecosystem and the Agulhas Current System. Existing material should now be tailored by colleagues from other African EAMNet partners, who attended the "training for trainers" during the Workshop, to complement research questions in their regions and integrate into the existing MSc modules presented at their universities. Module materials should also be available online in future courses and workshop collaborations so that trainees are afforded the opportunity to be better prepared for participating during the EO lecture and practical presentations.

Bilko, the main EO tool used (and improved) in EAMNet, is a very effective tool for introducing image visualization and manipulation, but it would also be useful to produce less cumbersome regional ENVISAT practical exercises that demonstrate time series analysis techniques and spatial data statistical analysis. Such a development would greatly assist in the speedy demonstration of remote sensing application avenues for end users during the limited time available for practical sessions. Currently students and professionals do not have access to free image analysis software that incorporates on the fly statistical analysis without requiring programming experience. Further

development, exposure and distribution of Bilko would facilitate the use of marine spatial data to a much wider audience.

It is imperative that course coordinators are consistent when evaluating the MSc EO short module delivery and participation. The course evaluation forms distributed during the African Operational Oceanography Workshop provided excellent feedback on the quality of the materials presented and the presentations themselves. This information should be critically (thoughtfully) incorporated when modifying existing material or augmenting the overall content during future short course implementations.

3.2.5 Regional training courses

Five courses were delivered over the course of the project as follows:

- First EAMNet course in Cape Town, June 2011
- The Ghana training course in West Africa in March 2012. EAMNet provided lecturers and financial support.
- The Tanzanian course in East Africa in August 2012. EAMNet also provided lecturers and financial support to enable the course to have a regional character.
- The JRC Satellite oceanography course, which EAMNet co-sponsored and supported attendance of both lecturers and trainees. The course was held the week after the AARSE 2012 conference following the EAMNet third annual meeting in El Jadida, Morocco, North Africa, in November 2012.
- The second Ghana training course in West Africa in March 2013. EAMNet provided lecturers and financial support.

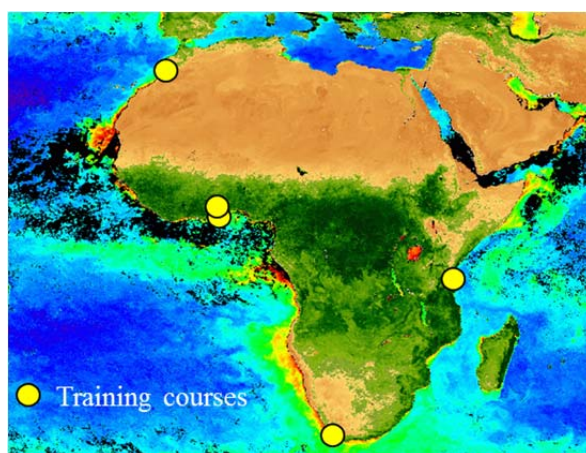


Figure 9. EAMNet Training courses

Overall conclusions

The EAMNet regional training programme was originally planned (in the EAMNet Description of Work) to provide input to courses run by external organisations such as POGO. The lack of such courses in the early years of EAMNet led to a proactive approach where the two courses planned at Universities of Ghana and Dar-es-Salam were modified from local courses to national or international courses with support for attendees including trainers, researchers, and students.

This plan proved to be very successful. In total there were over 90 attendees (of whom 24 were female) at the four courses (see Figure 10) from 16 different African countries (Eritrea, Morocco, Uganda, Ghana, South Africa, Cameroon, Togo, Egypt, Ivory Coast, Tanzania, Mozambique, Benin, Côte d'Ivoire, Comoros, Seychelles and Kenya). Each course used a basic set of material developed in EAMNet, but additional material was tailored to local issues, such as coral reef monitoring, or additional requirements, such as GEONETCast receiver training. In the El Jadida course practical sessions included training on the applied EAMNet methodologies to topics chosen by the students to suit their own research interests or key topics of importance to their home institutions. Some of these topics have the potential for being developed into new, regional training resources to supplement existing EAMNet lessons.

The training of trainers was very successful with, in addition to training the leaders of Ghana and Tanzania courses, thirteen recognised training assistants or lecturers supported from Ghana, Mozambique, Uganda and Eritrea.

The courses were on the whole considered very highly as reported in the course questionnaire feedback.

A number of issues were raised at the courses, and through other EAMNet deliverables, that should be considered:

- It was generally felt that the length of the course is too short. The Cape Town course introduced the EO material in one week while the Ghana, Tanzania and Morocco courses took two weeks. In most cases a three week implementation would be preferable, to allot greater time to learn complex issues, for longer practical sessions, and possibly for a field-trip. It was also suggested that the courses become residential (this was implemented for the second Ghana course).
- Computing and internet problems were a common theme in some courses: this is an issue that is not easy to address since it is not desirable to hold courses only in countries with an existing infrastructure.
- Deliverable D310.1 highlighted the need for greater technical training, specifically programming skills and some basic systems administration skills. The current two week course format is prohibitively short in this regard, but expanding to a longer course format could allow the 2-3 days necessary to build some momentum in the more technical areas

	Training Venue					
Host Institute	UCT, South Africa	UDSM, Tanzania	UG, Ghana	JRC/EAMNet Morocco	Second UG Course	Total
Benin						 X3
Comoros		 				 
Cote d'Ivoire						 
Egypt						 X2
Eritrea						
Ghana	 X2		 X3  X11		 X4  X11	 X7  X25
Kenya						 X3
Morocco				  X2		  X2
Mozambique	  X4	 X2				  X6
Seychelles		 				 
South Africa	  X5  X5			 		 X6  X6
Tanzania	 X4	 X2  X7				 X2  X12
Uganda	 	 X2		 X2		 X5 
Total	  X7  X20	 X6  X13	 X3  X12	 X5  X8	 X4  X11	 X25  X64

Figure 10. Students attending training courses by country and gender

Recommendations

1. Future courses should have two formats, synchronised at a continental level e.g. through GMES-Africa.
 - a) The three week format, much requested by course attendees, could focus primarily on students and active researchers, providing more detailed theoretical and scientific underpinnings to the EO applications. The three week format would also allow a two-three day teaching period for basic EO-focused Python programming, as recommended in D310.1. This could provide a powerful platform for further researchers and specialist users.
 - b) A one week course format could focus more on the needs of end-users, e.g. resource managers and environmental scientists, who wish to be able to use disseminated products in an informed manner, but who cannot invest three weeks in a course.
2. The training of the trainers was shown to be very successful, and future implementations of the course should specifically invite applications from, and prioritise applicants who are likely to further teach the material.
3. A significant outcome of the meetings was the decision at the Tanzania course for the students to create a network to maintain contact and share information including further development. The idea was to expand this to include participants from the other courses and fellowships to join. Creating a group of potentially 100 students with a common experience and training would be an excellent legacy from the EAMNet project since mutual support and interaction amongst a cohort of students has been found to work well, for example with students attending the world-wide POGO fellowships. This forum could also form the starting point for future follow-on or related capacity building and maintenance projects. The students themselves also realised the value of using existing initiatives such as WIOMSA and to use data from the GEONETCast systems installed by DevCoCast, EAMNet, AMESD and forthcoming in MESA. Hence, it is planned to create a user forum based on the EAMNet web site, which will allow users to share and develop training resources, and develop research collaborations. The network will be, as far as possible a self-sustaining entity, and will be based around the new EAMNet Alumni Network bulletin board, expected to come online end-August 2013.
4. A further recommendation from the Tanzania course was that “Most of the scientific instrumentation needed for marine research is very expensive; as such collaboration between scientists working at different institutions of the same country could provide avenues for sharing the existing facilities. The support from donors could also yield maximum output where the existing institutions were strongly coordinated rather than when the existing institutions were disjointed.” This should be pursued further in forthcoming initiatives supporting the marine sciences in Africa.
5. There is a further need for hands-on training material with a more regional focus, which could be met in future by regional trainers and students working together to develop such material for their region. Future projects in the framework of GMES could optimise the effort spent on capacity development by providing support for the development of regional training materials through networks that link lesson developers and allow them to share experiences and training resources such as background information, processing algorithms etc.

3.2.6 Training of trainers

It had originally been planned in the EAMNet Description of Work to invite trainers or lecturers from other African universities to attend the second course to be given in Cape Town. It had been envisaged that approximately six lecturers could be invited and supported in their attendance. As noted in

deliverable D320.2/D350.2a the leaders of the Ghana and Tanzania course attended the first Cape Town course. The extension of the scope of the Ghana and Tanzania courses from purely local implementations to national or international scope, and the greater involvement of EAMNet in the JRC course, provided an opportunity to include trainers in these courses as well. The second Ghana training course was able to support a number of trainers from with the University of Ghana and also the University of Cape Coast. However, this is a narrow definition of trainer since it can be expected that a number of the PhD students or early-career researchers will undertake tutoring or teaching roles and may be expected to have teaching commitments as their careers develop. Such people who attended the training as trainees but are likely to become future trainers at their home institutions included Mr Johnson Grayson from the Sokoine University of Agriculture (Tanzania), Mr Avelino Langa from Eduardo Mondlane University (Mozambique) and Mr Helder Machaieie from Eduardo Mondlane University (Mozambique). Other evidence of “training of the trainers” is evident in the actual teaching of the courses: Ms Hayley Evers-King, a PhD student at UCT very successfully taught the ocean colour components of the module at the UDSM implementation, and Ms Marie Smith, another PhD student at UCT, helped teach the practical sessions at the El Jadida course.

An important aspect of the “training of the trainers” is the ability of the newly trained to teach the course to additional new students – this is an extremely important issue as it shows a newly independent capability. Whilst European and South African trainers were present at both the UG and UDSM implementations to teach some of the more technically demanding components, both courses were led by local trainers, which is very positive and encouraging evidence that EAMNet has created a new pedagogical capability in West and East Africa. The El Jadida course included participants from all African regions, several of whom are likely to make future contributions to training in their home countries and provide case studies that may be used for development of training resources in the future - beyond EAMNet. Thus far, no mechanisms have been put into place to explicitly tutor and evaluate future trainers differently, as this could impose a somewhat non-egalitarian streaming process, and the organic process used so far has very successfully allowed “trained trainers” to emerge e.g. Kwame Agyekum from the University of Ghana, Siajali Pamba from University of Dar es Salaam, Hayley Evers-King and Marie Smith from the University of Cape Town. However, future training courses (see conclusions below) and auto-pedagogical material (see report D350.3) will be more specifically focused around different user skill levels and needs, and the new EAMNet Alumni Network bulletin board will allow longer term tracking of “trained trainer” activities and impact.

Finally it was also possible to teach a number of end users in government ministries:

1. Emmanuel Kwame Dovlo (Senior Research Scientist, Marine Fisheries Research Division, Ministry of Fisheries & Aquaculture Development)
2. Muna Naa Amoo (Fisheries Officer, Ministry of Fisheries & Aquaculture Development)
3. Mr. Mawuli Gbekor (Senior Programmes Officer, Environmental Protection Agency, Ghana)
4. Lt Odoi Narh (Naval Officer, Ghana Navy)
5. Ms Elke S. Talma (Project Officer at Sustainability for Seychelles coastal resources); Nationality, Seychelles.
6. Mr Phillip Haupt (project coordinator, Seychelles Island Foundation), Seychelles.
7. Mr Farid Anasse (Head of GIS Department, Ministry of Environment and Fisheries), Comoros.
8. Ms Anritoiti Tohir (Head of Department of Monitoring/Evaluation, Ministry of Finance), Comoros.

3.2.7 Autodidactic core components of the MSc module

The aim of the autodidactic version of the EO module was to extend the impact of the EO module beyond the core set of Universities by making the training materials freely available to anyone via the website. The autodidactic version of the module has been constructed using the general course components of the training material delivered at the universities of Cape Town (UCT), Ghana (UG) and Dar-es-Salaam (UDSM). It consists of annotated lectures introducing the main remote sensing

techniques (SST, optical, SAR and altimetry), and a selection of hands-on computer exercises using the Bilko software with EAMNet (and other) data to teach image processing and analysis skills. These exercises follow pedagogical principles that have been tried and tested in the UNESCO Bilko project over many years.

The EAMNet web portal (<http://www.eamnet.eu/cms/?q=node/113>) contains brief descriptions of the core material which link to further information and downloads on the Bilko site.

In addition, to ensure continued availability and potential future development of additional African material the autodidactic version of the modules have been made available in a specific EAMNet section of the UNESCO-Bilko web site at <http://www.bilko.org/eamnet>.

The Powerpoint lectures have been modified to take account of feedback, and annotated with detailed text in the 'notes' pane of the presentation, to allow lecturers other than the original authors to deliver the material. The notes are sufficiently detailed for the presentations to be useful also for students working alone or with limited supervision.

The hands-on computing exercises also follow established pedagogical principles developed for distance learning. Each lesson contains sufficient background information to allow students to understand the reason for the lesson activities, and to enable them to answer the questions posed as part of the lesson. Model answers are provided to allow students and trainers to check their understanding and ensure that they are on the right track. The lessons come complete with all data and additional processing tools (palettes, formulae, filters etc.) to allow students to carry out the lesson activities.

Three new lessons have been completed and tested during EAMNet and have been made available on line. In addition, a number of other lessons are still under development, in collaboration with former EAMNet fellows and associates, and will be made available under the EAMNet banner after the formal end of the project. (Note these are not formal EAMNet deliverables but are based on developments beyond activities funded by EAMNet, such as the fellowships.)

To encourage completion of outstanding lessons and promote on-going development of these resources, EAMNet has provided three supplementary prizes to African authors in the LearnEO lesson writing competition (see <http://www.learn-eo.org/competition.php> and http://www.bilko.org/eamnet/eamnet_africa_prizes.php). Past EAMNet fellows and others in the network have been encouraged to participate.

Autodidactic training plans have been proposed, based on the use of the EAMNet resources supplemented with material from other sources, to support access for students with varying abilities from beginner level users to marine science professionals to future EO experts. For each persona the material was classified into two types: a) remote sensing theory and b) hands-on exercises in satellite data analysis and interpretation. The report D530.2 gives full details of the personae.

EAMNet has built a community of marine scientists who combine their research interest with active engagement in Earth observation education. This community will continue to collaborate on the further development of autodidactic training materials, facilitated by the Bilko project office. It is recommended that the community makes a full contribution to the training network proposed in the GMES and Africa Marine and Coastal Chapter recommendations for a marine and coastal service.

3.3 Objective 3: to support development of GOOS Africa as a contribution to a worldwide observation system and improve coordination of existing GMES research and services activities in Africa.

The fellowship programme provided an opportunity for students from a wide range of backgrounds and with varying abilities to increase their understanding and gain experience by spending time at an

institute with different tools and specialisms. While developing individual capabilities in young and mid-career scientists, the programme also fostered significant links between the institutes themselves, which have and will lead to collaborative working opportunities in the future.

3.3.1 Targeted Fellowships

The aim of the EAMNet Targeted Fellowship programme was to build upon existing expertise in African Universities and Marine Research Institutes that were partners in the EAMNet project, through exchange visits with centres of excellence in Africa and Europe. The exchanges were targeted in the sense that they were in areas of key interest as identified by the EAMNet consortium partners in consultation with the Advisory Board and in particular with GOOS Africa.

The exchanges were planned to be up to 3 months duration with staff, travel and subsistence costs covered by project funds. To be consistent with POGO fellowships a travel budget (flight and local travel) of ~€1000 and living costs ~€1000 per month was paid and costs were included in partners' budgets. Between the four African partners the travel and subsistence budgets totalled €54,000: this aimed to support 12 targeted fellowships in total.

The targeted fellowships were coordinated by the parent institutes in association with the respective host institute. This proved very effective as the fellows were able to plan and organise their own travel and accommodation without requiring support from the coordinator (Plymouth Marine Laboratory). Furthermore, the parent institute, as a partner to the EAMNet project, had their own budget available to provide living expenses to the fellow which avoided money transfer challenges experienced on the Open Fellowship programme (please refer to D420).

The exchange visits were documented via a report and the recipients presented results of the visit during the EAMNet meetings coincident with AARSE conferences. PML coordinated this sub-WP and hosted placements as did MF-CMS, DMI, NERC and UCT

Results

Twelve targeted fellowships took place during project with all four of the African partners participating: these are shown in Table 1 and graphically in Figure 11. The duration of placements varied from one week to three months according to the applicant's availability and the requirements of their placement. Most partners contributed to the delivery of the fellowships except for EUMETSAT, where no activity was planned, and IMAR, who planned a placement for a fellow from the University of Ghana but the fellow's visa was not granted in time for this to go ahead.

All of the fellows were male, which highlights a significant gender disparity in the programme. However, as the parent institutes were organising the placements and selecting the fellows themselves, PML had limited involvement in this process and did not feel it appropriate to attempt to influence the gender balance. In addition, it would not have been appropriate to positively discriminate and we trust that the partner institutes selected the most appropriate candidates for the placement, regardless of gender, which does indicate that the gender disparity is possibly a reflection of an actual imbalance within these departments / subjects at some African universities.

Plans were also made for two additional placements; firstly for Kwame Agyekum of the University of Ghana (UG) to visit the Institute of Marine Research (IMAR); and secondly for Nyamisi Peter from the University of Dar es Salam to visit the National Oceanography Centre (NERC). Unfortunately their visas were not accepted in time for the placement to be completed by the end of the project.

Table 1. Targeted Fellowship placements

Name	Parent	Host	Topics
Targeted Fellowships that took place in 2010-11			
Christo Whittle	UCT	PML	Time-series analysis of Agulhas Bank upwelling in support of PhD thesis, and interacting with various researchers to discuss/ascertain the appropriate analysis techniques to assist in investigation.
Avelino Langa	UDSM	UCT	Analyses and interpretation of satellite data
Siajali Pamba	UDSM	UCT	Operational Oceanography and Earth observation, Analysis of Suspended Particulate matter and the use of Remote sensing image processing software
Kwame Agyekum	UG	PML	Using ocean data (ocean colour and sea surface temperature) via GEONETCast for fisheries resource management
Wahid Moufaddal	NIOF	PML	Comparative analysis of MERIS CoastColour and EAMNet data and assessment quality of their application on Egyptian water in the Red Sea and Mediterranean
Targeted Fellowships that took place in 2011-12			
Andy Rabagliati	UCT	PML	OceanSAfrica & the South African Very Large Data Base Design and Implementation of a Marine Information System
Kahitira Bwire	UDSM	Bangor Uni	Fundamentals of remote sensing Sea Surface Temperature
Targeted Fellowships that took place in 2012-13			
Yohanna Shaghude	UDSM	NERC	Analysis of MODIS SST Satellite Data
Maged Hussein	NIOF	DMI	Retrieve Altimetry Satellite data and Apply Wave Model (WAM) on Eastern Mediterranean and compare the output of these data.
Maged Hussein	NIOF	UCT	Methods and Applications of Ocean Colour Remote Sensing in Coastal and Regional Seas
George Wiafe	UG	MOI	Familiarization of MOI application of earth observation data in coastal and marine resources management in the Indian Ocean as part of the African Monitoring of the Environment for Sustainable Development (AMESD) Project (2007 - 2013), and preparation for the follow-on Monitoring for Environment and Security in Africa (MESA) Project (2013 - 2018).
Wahid Moufaddal	NIOF	MF-CMS	Training on management and processing of EUMETCast reception station data for better use of national and regional marine observation data

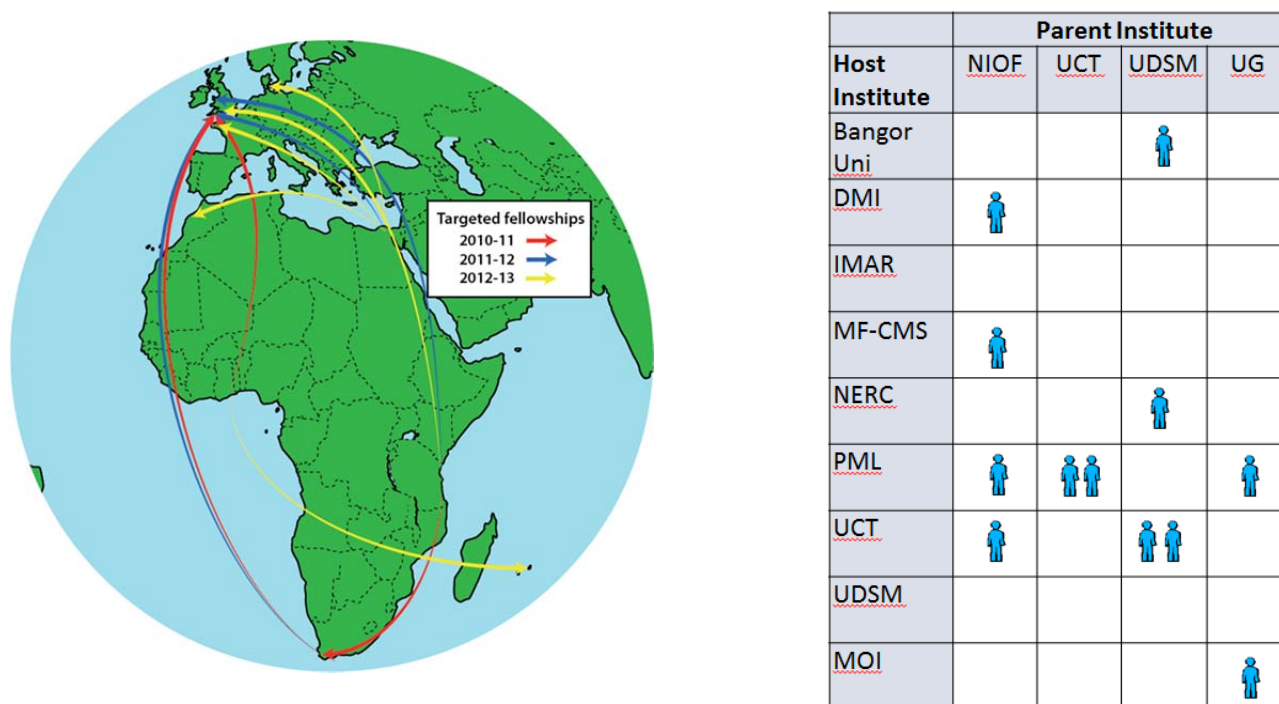


Figure 11. Table and map showing EAMNet Targeted Fellowship placements by institute

Feedback on the Fellowship Programme

For each fellowship placement that took place a report was collected from the fellow, their host supervisor and the supervisor at their parent institute in order to collect feedback on the nature of the placement as well as the usefulness to both the individual and the organisation.

A full account of each recipient's feedback is provided in D410.2. Overall, all of the respondents provided positive feedback as to how they will apply their training at their parent institute with most listing how this will be done including; enhancing the delivery of lectures given, the delivery of new training material and further research.

The Supervisors were asked to consider whether the placement would lead to future collaborations between the host and parent institute. All of the responses received were positive stating that collaboration was already underway, would definitely happen or they were hopeful that it would.

All of the individuals were asked to comment on the Fellowship programme and all of them returned positive comments calling the programme 'highly valuable', 'crucial' and 'very relevant'. Recommendations to improve future programmes, following insight deemed from the feedback received is provided in D410.2 under 'lessons learnt and recommendations'. A selection of the responses is copied below to summarise the positive appraisal of the programme.

- Christo Whittle: "The scientific discussions with scientists at PML and their guidance in EO data analysis provided an invaluable input to my PhD investigations. This exposure precipitated some life changing decisions with respect to my career development. My interaction with the focussed research environment at PML and the knowledge that a similar environment was to be found at the Council for Scientific and Industrial Research (CSIR), was a major motivating factor in my move from the University of Cape Town to a post as researcher within the Earth Observation Group at the CSIR" (visited PML from UCT)
- Avelino Langa: "The program is crucial for scientists who want to share their work with other scientists. These kinds of interactions can improve the way of thinking of young scientists when

they work closely with more experienced scientists, thereby contributing the flow of scientific knowledge for all who need it.” (visited UCT from UDSM)

- Wahid Moufaddal: *“The program provides an excellent opportunity to improve the technical and scientific skills of the trainees. It is also very useful for strengthening scientific cooperation and exchange of expertise between the host and parent institutions. This should lead to useful outcomes that imprint positively on the project progress and support its success. I strongly recommend its continuity.”* (visited PML and MF-CMS from NIOF)
- Stewart Bernard: *“It is a great opportunity that allows students to increase their knowledge on their research subject by exposing them to new people, ideas and techniques that may not be available at their own institutions”.* (UCT Supervisor)
- George Wiafe: *“The Fellowship is a great idea to enhance execution of such projects and also provides great opportunity for young scientists to benefit from expert advice and training”.* (Supervisor and Fellow at UG)

Conclusions and links with other work packages

The fellowship programme provided valuable opportunities for African scientists to develop their expertise in the field of EO, providing new knowledge that they have taken back to their own university or Marine Institute to share with colleagues and students. Furthermore it has established professional relationships and cross-working between centres of excellence in Africa and Europe, collaborations which are likely to continue into the future.

The aim of the targeted fellowships was primarily to coordinate and harmonise Africa-EU R&D activities, spreading best practices, involving African stakeholders in GMES service development in areas of high relevance to the development of GOOS Africa. However, the fellowships also supported the EAMNet objective of a “continuum of capacity building and maintenance activities”. For example,

- Several of the fellows were from institutes that have had receiving stations installed as part of the EAMNet project under WP200 or a previous EU project DevCoCast. The training they received through their fellowship supported the institute’s use of the receivers and thereby added value to this work package.
- Many of the fellows were able to attend one of the AARSE conferences in 2010 or 2012, or accompany the EAMNet project leader to EAMNet project meetings
- Fellows were encouraged to write articles for the EAMNet newsletter acting as motivation to other African scientists.
- Fellows were encouraged to use their results and experience to create case studies and computer-based hands-on exercises demonstrating regional applications, to supplement the core material developed for the MSc module.(WP340 and 350).

The targeted fellowship programme was managed by the partner institutes and therefore avoided many of the challenges experienced delivering the Open Fellowship programme, such as difficulties transferring money for living expenses and cancelled flights (see deliverable D420). This model could be used again in the future with minimal alteration to the current structure.

Of the 13 fellowship 10 were hosted by European institutes. Although this is in-line with what was initially expected it is recommended that in a follow-up/future project, such as in GMES and Africa, that greater reliance is placed on African centres of excellence. This is highly likely since with the existing AMESD marine and coastal Regional Implementation Centre (RIC) in Mauritius complemented by a second, West Africa, RIC in Ghana there will be at least two more centres of excellence to complement the University of Cape Town.

3.3.2 Open Fellowships

The aim of the EAMNet Open Fellowship programme was to build expertise in African Universities and Marine Research Institutes by providing the opportunity for exchange visits with centres of excellence in Africa and Europe. The fellowships were modelled on the POGO-SCOR Fellowship program under which young scientists from developing countries can study for up to three months in a POGO-member laboratory. The POGO program is currently oversubscribed by a factor of eight but the number of African applicants was quite low.

The fellowships were open to any African researcher (either within or outside the consortium) who proposed an area of collaboration relevant to the aims of the network. The fellowships were widely publicised through EAMNet and other mechanisms to ensure a healthy uptake and competition for places. The fellowships provided travel and living costs only for the exchanges (i.e. not including staff costs for the hosting site or the fellow's institute) so as to be consistent with existing POGO-SCOR fellowships.

The open fellowship programme was initiated in 2010 with an open call for applications, followed by subsequent calls in 2011 and 2012. The announcements were promoted through the EAMNet website and newsletter and disseminated through the network of partners and affiliated institutes and projects. The 2011 and 2012 calls were made available in English, French, Portuguese and Arabic (see D420.2).

Each call was issued at least two months before the deadline for submission, allowing plenty of time for interested parties to contact potential hosts and prepare their applications. Once the deadline had passed all of the applications were sent to an international review panel comprising the EAMNet Steering Committee members including Prof Geoff Brundrit (Chair of GOOS-Africa), Dr Justin Ahanhanzo, (UNESCO-IOC, Paris, Coordinator and Team Leader, GOOS-Africa Programme and "UNESCO Cross-cutting project on the Application of Remote Sensing for Integrated Management of Ecosystems and Water Resources in Africa" and Member of the AARSE Board of Trustees); Dr Mark Dowell (EC Joint Research Centre) and Dr Rezah Badal (Mauritius Oceanographic Institute) as AMESD Representative. A scoring system, based on the one used by POGO, was used to grade the quality of the proposal, quality of the host, quality/capacity of the parent institute, sustainability, capacity building potential, relevance and whether the subject was a priority area. The responses were combined and an average score identified for each applicant. All applicants that scored above a predetermined threshold were accepted onto the programme.

Results

Sixteen open fellowships were awarded over the three years of the project but one was later cancelled by the fellow (Table 2). All of the fellows were supported by PML staff through the application and planning stages of their placement to arrange travel, accommodation and the payment of their living allowance. The duration of placements varied from three weeks to three months according to the applicant's availability and requirements. A living allowance, of up to €1,000 per month, was paid to each fellow to cover their accommodation, food and internal travel requirements. The amount of the stipend was allocated based on the cost of living in the country visited as advised by the host institute.

The majority of applicants were male with only three females. This gender disparity was recognised after the second call and steps were taken to encourage more female applicants before the final call. This consisted of an article from the first female fellow, Benedicta Oben, being published in the EAMNet newsletter, and, based on Benedicta's advice, the text of the call was adapted slightly to limit perceived barriers that may discourage female scientists. Following this, two female fellows applied for the final call and were both successful.

Although some of the placements proved more challenging than expected, and there are recognised improvements that could be made in the future, overall the programme proved to be a great success and has received very positive feedback from all those involved. A map of the fellowship placements is shown in Figure 12.

Table 2. Open Fellowship Placements

Name	Parent	Host	Topics
Open Fellowships awarded in 2010-11			
Adesina Adebjie	Nigerian Institute for Oceanography and Marine Research, Lagos	National Oceanography Centre, UK	Sea Level Station Installation, maintenance and data analysis
Lazare Akpetou	Centre de Recherches Océanologiques (CRO) Abidjan	Plymouth Marine Laboratory, UK	Implementation of ecological indicators from ocean-colour remote sensing in the Gulf of Guinea large marine ecosystem
Joseph Amollo	Kenya Meteorological Department, Nairobi, Kenya	National Oceanography Centre, UK	Earth observation data and their application to the development and testing of shelf-sea models used for mapping vulnerability to extreme events such as storm surges and tsunamis
Benedicta Oben	University Of Buea, Cameroon	National Oceanography Centre, UK	Using remote sensing and satellite based techniques to relate environmental quality data/ocean quality data with potential or actual presence of algal/pathogen assemblages and other pollutants affecting living aquatic resources and human health and their response to climate change
Koffi Yao	Centre De Recherches Oceanologiques Abidjan	University of Perpignan, France	Measurements and data analysis of CO ₂ / Carbonate system in seawater as well as in water quality studies
Open Fellowships awarded in 2011-12			
Julius Ibukun Agboola	Lagos State University, Lagos, Nigeria	University of Cape Town, South Africa	The aim of this study is to analyse the trends of change in some coastal water quality parameters, such as; Chl a, primary productivity, living resources, ecosystem goods and services and management/cultural practices in selected locations using available ground-based and satellite data from coastal systems on the West African coast and to deduce some natural and anthropogenic drivers of observed change
Ousmane Diankha	Laboratory of Physics of the Atmosphere and Ocean Simeon Fongang ESP-UCAD, Senegal	University of Ghana	The evaluation of primary production along the Senegalese coast to quantify its impact on the fluctuations in marine species using remote sensed imagery. This study will contribute to the improvement of the management and assessment plan of marine resource for a sustainable development in Senegal.

Name	Parent	Host	Topics
Shigalla Mahongo	Tanzania Fisheries Research Institute	University of Ghana	The objective is to undertake statistical modelling of mean sea levels along the coast of East Africa to determine and forecast sea level on a regional basis. The variability of mean sea level along the coast is important for marine life, anthropogenic effects and processes such as shoreline erosion.
Brice Mobio	Université de Cocody, Côte d'Ivoire	University of Cape Town, South Africa	• Apply Maximum Cross Correlation (MCC) technique to chlorophyll images from MERIS to locate more accurately the area where the eastward Guinea current and the westward sub-current meet. • Develop skills to conduct studies on variability of sea surface temperature, chlorophyll concentration, salinity and fishing, especially in the area where the eastward current meets the westward current on the Ivorian continental shelf. This study will then be extended to the entire Gulf of Guinea to allow a regional study.
Open Fellowships Awarded in 2012-13			
Tabi Elizabeth Biche	Institute de Recherche Agricole Pour le Développement (IRAD), Batoke.	University of Cape Town, South Africa	Interpreting satellite ocean water quality estimates vis-a-vis in-situ measurements for environmental safety and sustainable fisheries management, such as: Exploring the possibility of using models and satellite imagery to predict cyanobacterial bloom transport. Learning how to detect and map fronts around the Cameroon Gulf of Guinea that could be indicators of marine biodiversity hotspots in the region for use in sustainable ecosystem-based fisheries management.
Anthony Gidudu	Makerere University, Kampala, Uganda	Plymouth Marine Laboratory, UK	Time series analysis of MERIS derived geophysical parameters for Lake Victoria.
Imhansoloeva Titocan Mark	Nigerian Institute for Oceanography and Marine Research (NIOMR), Nigeria.	MA-RE Institute, University of Cape Town, South Africa	Sea level measurements, data analysis, forecasting and modelling: Visit to tide gauge stations Sea level measurements Evaluating and accessing Earth Observation coastal altimetry Sea level data processing and analysis Modelling (Storm surge) and predictions

Name	Parent	Host	Topics
Dr Prince Emeka Ndimele	Department of Fisheries, Lagos State University, Lagos. Nigeria	Department of Oceanography, University of Cape Town, South Africa	The relevance of remote sensing to biogeochemistry of oceans and other water bodies to understand the dynamics and fate of heavy metals in the aquatic environment.
Paul Ng'ala Oloo CANCELLED	Kenya Meteorological Department, Kenya	National Oceanography Centre, UK	Studying the Indian Ocean Dipole (IOD) in NEMO 1/12°, a state-of-the-art global ocean model, to understand the changes in currents, temperatures and thermocline depth. Model evaluation will be via comparison of data from the RAMA array, ARGO floats and the sea surface height and temperature data from satellites. This will help us understand and predict the development of the oceanic IOD events, and their impact on the regional weather in East Africa including Kenya.
Andriantsilavo Jean Michel Rabary	Institut Halieutique et des Sciences Marines, Madagascar	University of Cape Town, South Africa	Analysis of oceanographic data to learn how to manage and monitor seawater and its quality to understand subsequent impacts on pollution and climate change especially in the Mozambican Chanel.
Amadi Afua Sefah- Twerefour	University of Ghana, Ghana	University of Cape Town, South Africa	Oil spill detection and mapping to monitor spills and illegal discharges for improved monitoring and management of maritime activities in the Gulf of Guinea. Includes learning oil spill detection techniques with different imaging modes of SAR data and the development of techniques to output detected targets into GIS formats.
Dr Prince Emeka Ndimele	Department of Fisheries, Lagos State University, Lagos. Nigeria	Department of Oceanography, University of Cape Town, South Africa	The relevance of remote sensing to biogeochemistry of oceans and other water bodies to understand the dynamics and fate of heavy metals in the aquatic environment.

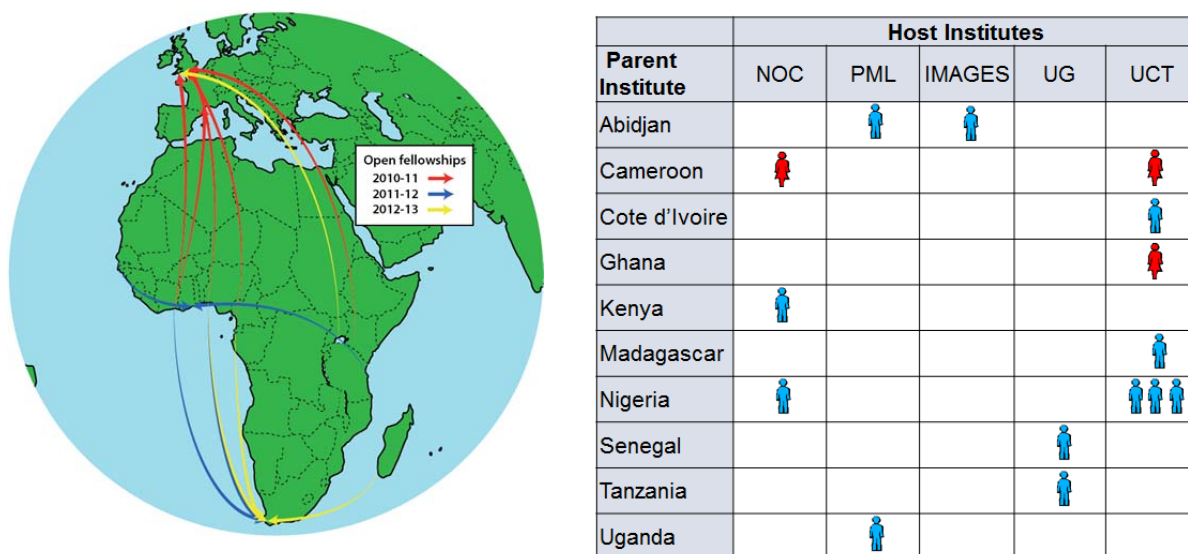


Figure 12. Map and table showing EAMNet Open Fellowship placements

Feedback on the Open Fellowship Programme

For each fellowship placement that took place a report was collected from the fellow, their host supervisor and the supervisor at their parent institute in order to collect feedback on the nature of the placement as well as the usefulness to both the individual and the organisation.

A full account of the feedback received is available in D420.2, all of the respondents provided positive feedback as to how they will apply their training in their parent institute with most listing how this will be done including; the delivery of training, further research, funding applications, and for one fellow, the assimilation of a targeted remote sensing team.

The Supervisors were asked to consider whether the placement would lead to future collaborations between the host and parent institute. All of the responses received were positive stating that collaboration was already underway, would definitely happen or they were hopeful that it would.

- Soro Métongo Bernard of the Centre De Recherches Oceanologiques (CRO) responded, “Conspicuously yes! We have planned to share students and more, work together on further projects” with regards to their collaboration with the University of Perpignan in France.
- Dr Ezekiel N. N. Nortey of the University of Ghana responded that collaboration with the Tanzania Fisheries Research Institute would “Certainly (would continue). We have already drafted a paper we will be presenting in a conference in Morocco in collaboration with another researcher in South Africa”.
- Prof Affian Kouadio of Université de Cocody in Côte d'Ivoire responded with “This exchange will lead to future collaboration because we plan to build at University of Cocody a master program in the field of operational oceanography. We will need collaboration with Dr Stewart Bernard and his team to make this program a successful one”.

All of the individuals were asked to comment on the Fellowship programme. All of their responses were positive with many using the phrases ‘successful’, ‘excellent opportunity’, and ‘relevant’. A full list of recommendations to improve future delivery of a fellowship programme, based on this feedback and the Coordinator’s experiences, are provided in D420.2 and some key points are summarised in the conclusion below. A selection of the responses is copied below to summarise the positive appraisal of the programme.

- Ousmane Dhianka: *“I do not find the best words to express and magnify how this fellowship is helpful and wonderful for the young African oceanographer I am. I think from this fellowship you are helping Africa to build the capacities of the next and future scientist in the use and exploitation of EO data”* (visited UG from Laboratory of Physics of the Atmosphere and Ocean Simeon Fongang ESP-UCAD, Senegal)
- Lazare Akpetou: *“excellent opportunity especially for early career African scientists who can build a solid background in Ocean Sciences and Earth Observation”* (Visited PML from CRO)
- Joseph Amollo: *“The EAMNET fellowship programme is appropriate and applicable to the development of research skills and also for future collaborations between various institutions”* (visited National Oceanography Centre in the UK from the Kenya Meteorological Department).
- Benedicta Oben: *“There are few programmes like this which give opportunity to African scientists in the Ocean Sciences to collaborate with their European colleagues thus making EAMNet a unique programme. This should be encouraged as there are potential research breakthroughs that could result and untapped research areas in Africa which could benefit from input of expertise and technology from Europe”* (visited NOC from the University Of Buea, Cameroon)

Conclusions and links with other work packages

The fellowship programme enabled EAMNet to extend the network beyond its beneficiaries, and receiving station recipients to develop links with other scientific institutes in both Africa and Europe. As well as early career scientists who participated as fellows, the programme developed links with their more senior colleagues and supervisors. Continuation of this network will not only ensure that it is viable and ready to respond to future opportunities to engage with EO projects of relevance but also that it is comprehensive. For example, the number of applicants to the fellowship programme grew with each year of the project, as more scientists across Africa became aware of it, if the opportunity arose to deliver this programme again we would be starting from a more extensive contact database which would likely attract more applicants in even the early rounds of the fellowship. This in turn would add value and provide greater scope to the selection process.

An aim of EAMNet was to provide a coherent approach to capacity building and maintenance in Africa. This was well demonstrated by the example of Dr Lazare Akpetou, Centre de Recherches Océanologiques (CRO), Abidjan, Cote d'Ivoire. Lazare was one of the first year of open fellowships, which he undertook at PML. Later he was supported by EAMNet to attend the AARSE 2012 conference where he won best overall presentation! Based in Abidjan he should be able to utilise data processed in WP220 covering his coastal regions and will be able to receive data via the GEONETCast receiver installed at Université de Cocody, Côte d'Ivoire.

In fact, several of the fellows were from institutes that have had receiving stations installed as part of the EAMNet project under WP200. The training they received through their fellowship will support the institute's use of the receivers and thereby add value to for the institutes involved. For example, Mobio Brice of Université de Cocody in Côte d'Ivoire provided feedback that, *“The training received will be used to process data from the EAMNet receiving antenna and their analysis for research projects of our institution”*.

A disparity in the gender balance of the applicants was recognised and addressed during the project. Future programmes should consider this as a potential issue at an early stage and incorporate ways to encourage female scientists and seek advice from previous female fellows that can offer an increased understanding of potential cultural barriers.

3.4 Objective 4: To create a forum for African engagement in GMES Africa

The aim of this objective was to provide a mechanism whereby the marine and coastal research and monitoring Earth observation community in Africa could engage with the GMES and Africa process. Although the stages of the process were somewhat delayed compared to the original time schedule, the EAMNet community has been intimately involved with the development of the Marine and Coastal Chapter from its inception at the JRC meeting in March 2009 to the Marine and Coastal meeting in Mombasa, Kenya in October 2012.

3.4.1 Engagement with the GMES and Africa Marine and Coastal Chapter

The Marine and Coastal Text, along with other chapters of the Draft Action Plan, was constructed during and following the “GMES and Africa” meeting at JRC in March 2009. At that time the EAMNet proposal had been submitted (in December 2008) but the outcome of the review was not known, and indeed the project itself only started in March 2010.

In fact, EAMNet participants contributed significantly to the initial development of the Marine and Coastal Area text. Prof. Geoff Brundrit, (GOOS-Africa) was African lead author and is a member of the EAMNet Advisory Board. Justin Ahanhanzo (IOC-UNESCO) and Mark Dowell (JRC) are both supporting authors and also members of the EAMNet Advisory Board, while Steve Groom (PML) coordinator of EAMNet, was a contributing author. Furthermore, the European lead author Dr Nic Hoepffner, JRC, was a partner in FP7 DevCoCast, attended the 2011 joint DevCoCast/EAMNet meeting in Antwerp and works closely with PML, UCT and NERC amongst others including the organisation of the joint JRC/EAMNet training course in El Jadida, Morocco, November 2012. Finally, Vincent Gabaglio, EUMETSAT, also an EAMNet partner, was European lead for the infrastructure Framework. So although the authors had the aims of EAMNet in mind whilst writing the Draft 0 text it was uncertain whether EAMNet would be funded.

Note that the original Draft 0 together with all subsequent versions is available at

<http://capacity4dev.ec.europa.eu/africa-eu-part.gmes/minisite/1-marine-and-coastal-areas-workshop>

In March 2010 EAMNet started and in summer 2010 the draft action plan was made available to open to review via an on-line process at www.aquaknow.net.

Given that the authors of the Marine and Coastal draft plan text were heavily involved in EAMNet the nature of engagement in the consultation had to be very clearly stated and obviously had to avoid self-review. Hence, the nature of the comments made in response to the on-line consultation were agreed with the EAMNet advisory board as follows:

- Comments were provided regarding the manner in which EAMNet may interact with or support development of a GMES and Africa Marine and Coastal initiative.
- Comments were provided on new European GMES initiatives that have started in the area (such as AQUAMAR) or associated with the major new European Space Agency Climate Change Initiative that obviously were not mentioned in the earlier text. This text is provided in Deliverable D600.2
- GOOS Africa, through the Chair and Technical Secretary, sent a letter to Dr Hamdy at the African Union Commission explaining the relationship with EAMNet.
- The EAMNet Coordinator followed this by sending a letter introducing the project and its representativeness of European and African marine science institutions and giving high level comments to Dr Hamdy.

Finally, individual EAMNet partners were encouraged to provide comments, in addition to the EAMNet text, to provide an independent perspective.

The input provided by the EAMNet partnership is given in Deliverable D600.2 and is also included in a document on the capacity4dev web site.

http://capacity4dev.ec.europa.eu/sites/default/files/file/08/10/2012_-_1309/gmes_africa_baseline_study_mc_areas_chapter_-_chronology_of_comments.pdf

However, the document on capacity4dev seems to have excluded all the comments from the EAMNet partnership other than that provided by the coordinator.

In 2011 an updated overview was provided by the original lead authors Prof Brundrit and Dr Hoepffner: this document is available within

http://capacity4dev.ec.europa.eu/sites/default/files/file/08/10/2012_-_1309/gmes_africa_baseline_study_mc_areas_chapter_-_chronology_of_comments.pdf

Marine and Coastal Workshop

The marine and coastal workshop was first mooted in an e-mail from the BRAGMA coordinator, Dr Ana Morgado, in early 2012. Throughout the year EAMNet made significant input to the success of the workshop through providing names, assisting with organisation and updating the draft plan as part of the Scientific Committee. The draft plan published on the capacity4dev website as “2.Draft 1 (Pre-WS) - Marine and Coastal Areas Chapter of GMES & Africa Action Plan” though note it is labelled Revision 18.09.2011 – it should read Revision 18.09.2012.

The meeting itself was attended by EAMNet partners PML, UG and UCT together with EAMNet Advisory Board member Justin Ahanhanzo. A presentation by Steve Groom (see Figure 13a) gave an overview of recommendations from EAMNet of relevance to the GMES and Africa action plan, specifically, on how the development of the four elements proposed in the draft plan (Marine Remote Sensing Centres, Modelling and Forecasting Centres, a Network of Coastal Observatories and An African Capacity Building Network of Higher Education Institutions) could benefit from lessons learned in EAMNet. Stewart Bernard described the OceanSAfrica project, and model for an integrated Marine and Coastal service incorporating EO data/Modelling and Forecasting/in situ data/training elements as proposed in the draft Marine and Coastal chapter. Together these presentations provided the initial recommendations from EAMNet to GMES and Africa as proposed at the second EC review meeting. This included a draft road map on key activities. The presentations are available at

http://capacity4dev.ec.europa.eu/sites/default/files/file/19/10/2012_-_1603/10_steve_groom_eamnet_mc_kenya_final.pdf

http://capacity4dev.ec.europa.eu/sites/default/files/file/19/10/2012_-_1607/14_stewart_bernard_oceansafrica_gmesafricamombasa_oct2012.pdf

Stewart Bernard led working group 3 on “EO Science & Technology for Marine and Coastal Areas” while Steve Groom was the rapporteur. Furthermore, it was originally planned that the rapporteurs (in the event only Steve Groom and Mika Odida) should link together the outputs from the three WG in “real time” to produce a set of recommendations on high, medium and low priority actions. However, due to over-running of earlier parts there was no time available to do this. Hence, on suggestion of Steve Groom the draft plan was made available for commenting upon by any workshop participant.

Subsequent to the workshop the EAMNet community met in El Jadida and a number of suggestions for changes were made to “Draft 1”. In particular, the structure of the proposed GMES and Africa Service for Marine and Coastal Areas was modified to more closely match the existing GMES MyOcean2 structure of EO centres and modelling and forecasting centres (see Figure 2.4.1).

a*b**c*

Figure 13a Steve Groom b) Stewart Bernard and c) workshop participants

3.4.2 Recommendations to GMES and Africa

The recommendations to GMES and Africa synthesize the results of the EAMNet project and are given in the sections above so not repeated here. The report on recommendations (D600) can be found at <http://www.eamnet.eu/cms/?q=node/12>.

Final outcomes

The final outcomes of the development of the marine and coastal chapter are as yet unknown. A validation workshop is planned for October 2013 but progress thereafter is uncertain

4 Potential impact, the main dissemination activities and the exploitation of results.

4.1 Project Impact

4.1.1 Creation of the network

The key success of EAMNet has been to create a network of African and European scientists that provides a focus for marine and coastal activities. The links have been created; through involvement as beneficiaries in the FP7 project; through open fellowships; through the various training courses; through the installation of GEONETCast receiving stations; and finally attendance at AARSE meetings.

The network now comprises ~170 people who have participated in one or more of these opportunities. A map of links is shown in Figure 14 while the country links in terms of attendees at the training courses is shown in Figure 10.

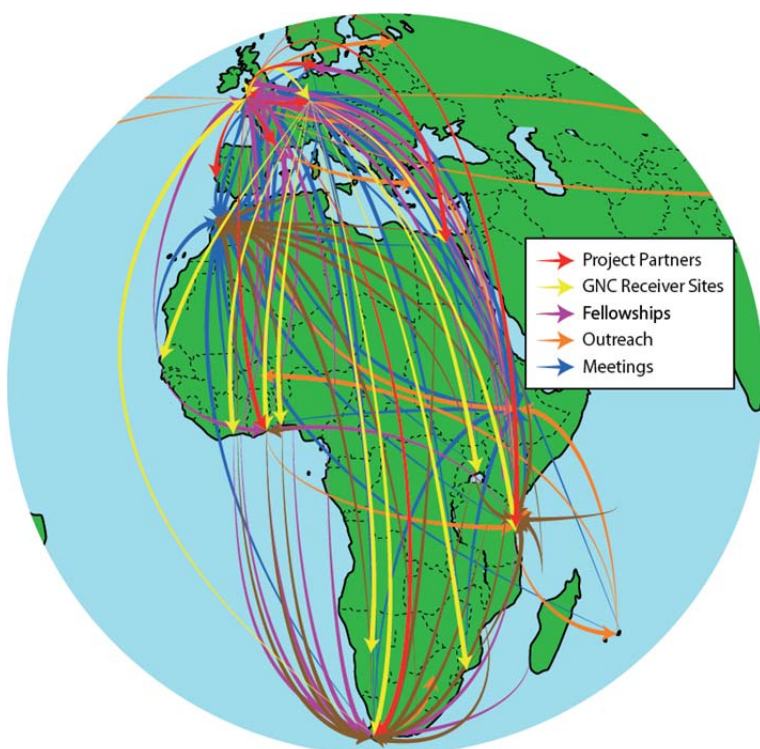


Figure 14 Map demonstrating the network links established by EAMNet

4.1.2 Spreading excellence and disseminating knowledge

Spreading excellence and disseminating knowledge continue to be fundamental goals for the EAMNet network and most of the activities delivered through the project have aimed at achieving this. Beyond the end of the project we will continue to spread expertise and best practices through a number of on-going activities that will be maintained and through the legacy of infrastructure and training. These will continue to have an impact. Specifically the network will be:

- Continuing to provide EO data products to Africa through the web site and GEONETCast transmissions.
- Leaving a legacy of five GEONETCast receiving stations for use in five African countries to receive EAMNet and other data.
- Encouraging exchanges of personnel between marine research centres, supported through schemes such as the Partnership for Observation of the Global Oceans (POGO), which will be promoted to the network.
- Promoting continued engagement in international conferences, such as AARSE, as opportunities for one-to-one contact, presenting of results etc. Throughout the project, participation in these events allowed dissemination of results and sharing of best practice. Although partners will have to fund their own participation in the future, they have now realised the opportunity for wider engagement with stakeholders that these events provide due to the large number of delegates in attendance.
- Continuing attendance at other stakeholder meetings, such as the EUMETSAT User fora, in order to continue to promote EAMNet to a wider audience than marine science and disseminate relevant information deemed back to the network.
- Similarly, European EAMNet partners engaged in other FP7 projects or ESA/EC Copernicus/GMES projects will have the opportunity to provide the African perspective to the wider European community
- Publishing informative newsletters, coordinated by PML with input from partners, and disseminate them to the network in order to maintain productive communication channels.
- Maintaining the project web site providing access to a wealth of resources and information.
- Producing an EAMNet leaflet to inform stakeholders across Europe and Africa of the progress achieved throughout the project and the continued aims of the network. The leaflet provides details of further sources of information, such as the project website, and invites interested parties to sign-up to receive the newsletter.

In addition, a project video has been made to provide an additional dissemination tool to our partners to use to share the experiences and best practices of EAMNet.

EAMNet partners will continue to investigate opportunities to publish results of scientific research, conducted through EAMNet fellowships and training, in popular journals.

- For instance, NIOF, have skills in popular scientific journalism and will be utilised to reach a wider audience. They could write articles for: 1) **'Al-Bia Wal-Tanmia' (Environment & Development) magazine**: A monthly Arabic magazine published in Arabic from Lebanon and covers issues and features related to environment, health and sustainable development. 2) **Science & Technology section, IslamOnline Net**: One of the most popular electronic sites in the Arabic region. It has a special and regularly updated section for publishing of science and technology news and related issues. 3) **'El-Elm' (Science) magazine**: A monthly Arabic magazine published in Arabic by Academy of Scientific Research in Egypt. It is one of the oldest scientific magazines being issued in the region.
- EAMNet may also contribute to SciDev.net (www.scidev.net) reporting on activities of wider interest to the African science / development community.
- The LMEs have a strong socio-economic component, which includes working with decision makers and local community groups. The close link into LME activities through African partners will allow EAMNet to reach a wider audience than marine research, case studies used to develop professional training material for coastal and marine applications of EO may easily be modified and adapted to allow presentations to a lay audience, either on the web or in other formats (e.g. talks, education material for schools). Such materials could be disseminated, for instance through existing ACCESS education efforts.

Exploitation of results

A number of EAMNet results are expected to be further exploited as follows:

- The EO module, presented in courses in south, north, east and west Africa, can be exploited by other African Universities and training institutes and the material to provide the course is available freely on the EAMNet web site.
- The autodidactic materials, based on the course, are freely available via GEONETCast and the web site and can be exploited by anyone. The materials can also be used external to Africa not least through the international ChloroGIN network.
- The experience gained through the exchanges of personnel will be exploited in terms of better procedures and processes in support of the GEO Blue Planet, AfriGEOSS, OceanSAfrica and GOOS Africa.
- The data provided will be exploited for operational monitoring and will thereby continue to contribute to sustainable development; the data should also be exploited by recipients in terms of evidence-based advice to policy makers.
- The data provided are being used by the MESA project. This usage is expected to grow with the second marine and coastal theme in west Africa coordinated by Dr George Wiafe, a partner and beneficiary in EAMNet.
- The coordination of African and European R&D should lead through to scientific publication with joint authorship.

The next stage of application of skills and data will be considered through GEO Blue Planet, AfriGEOSS, OceanSAfrica and GOOS-Africa. We will attempt to insert a stronger “sustainable strategic planning” component in meetings and fora and stress ability to influence the take up of these strategies through GEO, AU, SADC and national government links. The next stage is probably a strong focus on regional validation/product development and in situ observation empowerment (e.g. in OceanSAfrica); and multi-sensor, multi-temporal analyses for climate change related applications. The latter will in particular be framed by the forthcoming Copernicus/GMES Sentinel series of operational satellites. Both the targeted and open fellowships (WP 400) extended and strengthened existing networks by developing future collaborations for scientific research as well as product and applications development. The fellowship topics undertaken have developed skills that will support sustainable resource management and contribute to future operational activities based on coastal and marine EO.

4.2 Main Dissemination Activities

Effective dissemination and communication was integral to the success of the EAMNet project and supported the achievement of all four project objectives. Internal communication between project partners contributed to the effective delivery of collaborative project tasks while externally facing dissemination allowed the network to share opportunities, results and resources with the wider EO community in Europe and Africa.

In terms of internal project communication, this was largely achieved through annual meetings, remote conferencing and emails. More structured communication channels were utilised for external communication through the project website and newsletter, as cost-effective and openly available tools, which also supported communication between partners.

4.2.1 EAMNet Website

The EAMNet web site (<http://www.eamnet.eu>) is a central service designed used both as a coordination tool by project partners and a communication tool used in disseminating information to a wider audience.

From its inception the EAMNet website was kept simple and image-light in order to accommodate the target audience, who may have limited network connectivity and relatively low powered computers. It was built using a Content Management System (CMS) which allowed the technical support of the web site to be separated from the editorial control providing multiple access levels from simple viewing, to

editing text (by partners) and uploading of documents. Using a CMS also made it easier to add new features during the development of the project and to alter the “look and feel” as was required.

The web site was first on-line and visible to the public on 14 April 2010, it was established to provide a variety of information about the project and has been updated over the course of the project with new material and input from partners.

The content of the web site includes

- Information on the project, the partners and the network
- Project presentations and meeting minutes
- Access to the data portal (WP240).
- Training materials (WP350).
- Fellowship placements (WP400),
- Newsletters (WP520)
- Reports on symposia (WP530)
- EO Data Catalogue
- Completed deliverables
- Events listing

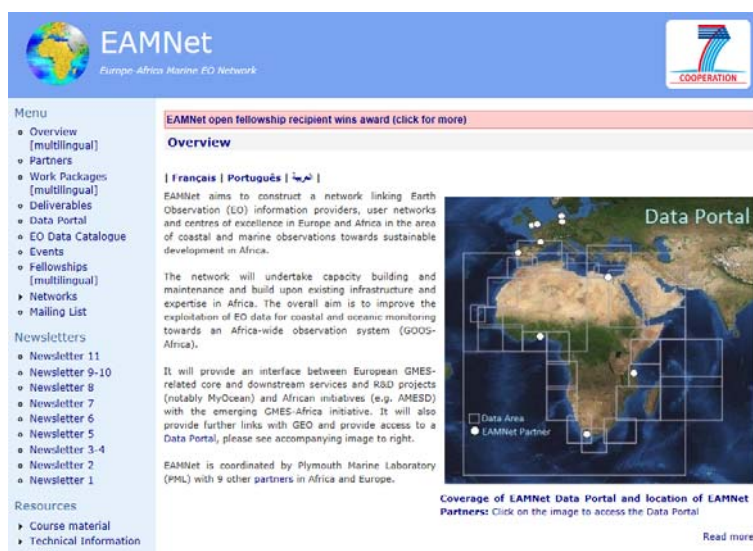


Figure 15. The EAMNet Home Page

During the course of the project, and in response to feedback, several of the pages were translated into French, Arabic and Portuguese, by project partners, to make key aspects of the website multilingual. This included the Open Fellowship call, making this opportunity available to a much wider audience in Africa.

In June 2012 a subscription feature was added to the website so that, as well as being able to download the newsletter from the site, interested parties could request to receive future editions and other EAMNet updates directly.

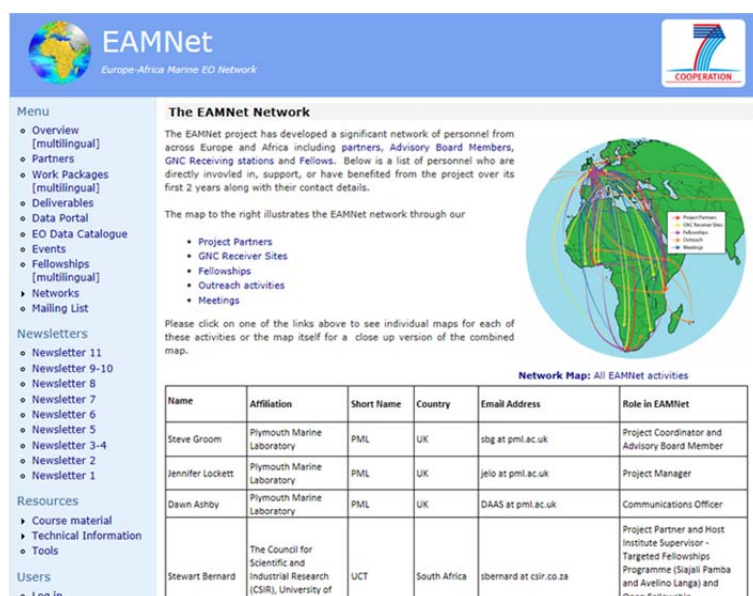


Figure 16. The EAMNet Network Page

Throughout the project PML, as Project Coordinator, monitored the use of the website. Initially this was recorded through an internal system but was upgraded to Google Analytics in April 2012 in order to access the much wider range of tools and visitor information that this provides.

Between April 2012 and 24th June 2013, 3,975 people visited the website and 36.6% of these visitors later returned with 6,249 visits recorded in total. The number of visitors to the site each month varied

from 290 in December 2012 to 636 in April 2012, a peak that correlated to the final fellowship call announcement.

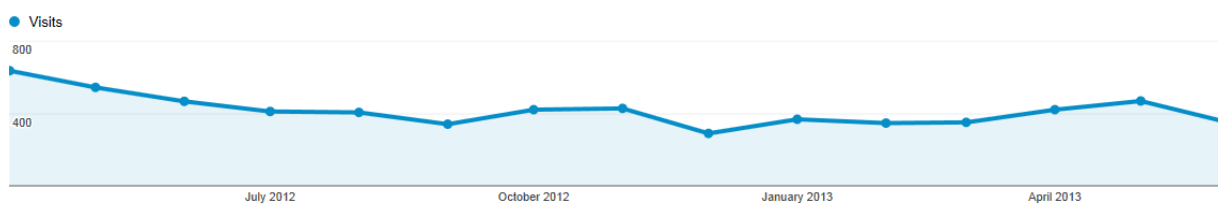


Figure 17. Website traffic, April 2012 – June 2013

The most popular page of the website, including the home page, was one of the resource pages that provided information on converting GRIB2 to Net CDF, this page received 2,661 visits during this period demonstrating how useful this information was to the EO community. The second most popular page, not including the home page, was Open Fellowships, which received 943 views, most of which were in April 2012.

An alumni forum has been set-up for students of all EAMNet training courses and fellowships, as well as any other members of the network, to communicate through an open access forum linked to the EAMNet website. This platform will allow students to share best practice as well as discuss new projects and tools. As the forum was only established in the last day weeks of August, there is still work to do to raise awareness and encourage use but the link is now live and accessible to all of the network at <http://www.eamnet.eu/forum/>.

4.2.2 EAMNet Newsletter

The EAMNet project published marine-focussed newsletters every few months of the project. The newsletter has been a key dissemination tool to share information both within and outside the network in Europe and Africa. It has benefited both internal communication within the project, to ensure partners, advisory board members and receiving station are aware of each other's activities and progress, as well as external communication to make the wider marine Earth Observation (EO) community aware of the work of the project and the opportunities that it has provided.

In addition to information and updates relevant to GMES and Africa, the newsletter has allowed dissemination of project updates, meeting reports, fellowship awards and much more. They have contained a broad range of articles which are related to the creation, production, dissemination and use of EO data available from a variety of sources. Each EAMNet partner has submitted articles related to their project activities and other wider information of relevance to the network.

The majority of editions of the newsletter were distributed by email as a PDF attachment. This reduced the download times for readers, particularly in Africa where internet capabilities can be limited, but also produced an easily printable document and permitted flexibility in the branding of the newsletter to make it more appealing to readers.

Initially the distribution list (those receiving the newsletter via email) consisted of the project partners, advisory board members and receiving station contacts. With time and the evolution of the EAMNet network, this grew to include fellows and their supervisors, coordinators from related projects, and other interested parties that learnt about the project through presentations at conferences and events.

In June 2012 a subscription feature was added to the website so that, as well as being able to download the newsletter from the site, interested parties could request to be included on the distribution list to

receive future editions of the newsletter by email. By April 2013 the distribution list included 79 recipients.

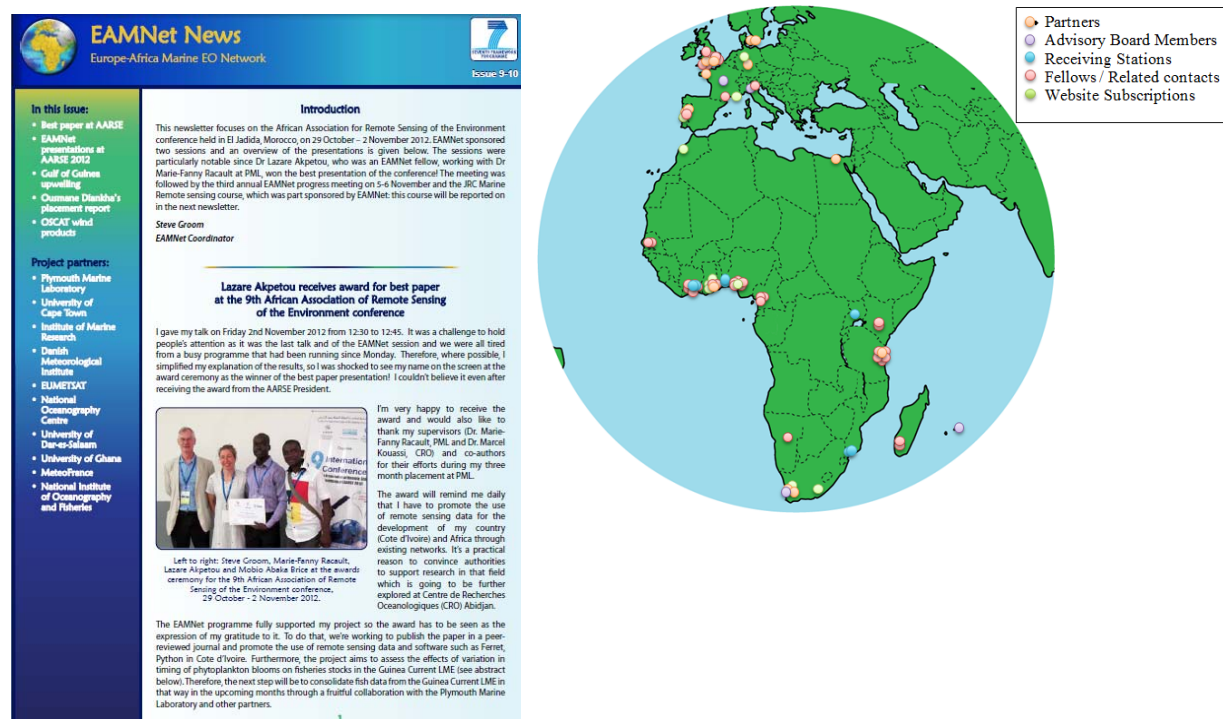


Figure 18. Example Newsletter and Newsletter Distribution Map

4.2.3 Other Publications

- EAMNet was included in the 2011 'Let's embrace space' publication on space research achievements under the 7th framework programme.
- A project leaflet and video are being developed to highlight and disseminate EAMNet's achievements. Electronic copies will be made available to the network so that they can be used on websites and in presentations. The leaflet has been designed to be easily printable so that partners may print copies for distribution at conferences and events.

5 Public website address and relevant contact details.

Project website address:	http://www.eamnet.eu/cms/
Project email address:	eamnetadmin@pml.ac.uk
Project office address:	Plymouth Marine Laboratory, Prospect Place The Hoe, Plymouth, PL1 3DH, UK

6 Matrix of Project Partners Activity

Institute	WP 100
PML	• Periodic preparation and submission of scientific and financial reports to EC • General project co-ordination • Financial management and distribution of • Legal management • Liaison with the European Commission • Reporting • Support of organisation and attendance to coordination meetings • Attending EC Review meetings
UCT	• Organisation and attendance to coordination meetings and teleconferences • Submission of scientific and financial reports to PML • Attending EC Review meetings
IMAR	• Periodic submission of scientific and financial reports to PML • Attendance at coordination meetings
DMI	• Periodic submission of scientific and financial reports to PML • Attendance at coordination meetings
EUMETSAT	• Periodic submission of scientific and financial reports to PML • Attendance at coordination meetings
NERC	• Periodic submission of scientific and financial reports to PML • Attendance at coordination meetings • Attending EC Review meetings
UDSM	• Periodic submission of scientific and financial reports to PML • Attendance at coordination meetings
UG	• Periodic submission of scientific and financial reports to PML • Attendance at coordination meetings
MF-CMS	• Periodic submission of scientific and financial reports to PML • Attendance at coordination meetings
NIOF	• Periodic submission of scientific and financial reports to PML • Attendance at coordination meetings

Institute	WP 200
PML	• Lead on WP200 • Lead partner for delivery of D210.2 report; First, second and third year data reviews • Produced on-line data catalogue • Production of D210.2 Technical Standards for New GEONETCast Marine Data providers • Delivery of D220.1 Extended range of products provided to Africa • Production of ocean colour and SST data throughout the project for EAMNet and AMESD areas • Maintenance of GEONETCast marine hub channelling data to Eumetsat for GEONETCast transmission • Production of data portal and deliverable D240.1 • Production of D240.1 EAMNet Web Site • Delivery of D210.2/D210.3 report; Web-based data catalogue and data reviews • Review of all WP200 Deliverables
UCT	• Input to data review DT210.1 & format review DT210.2, adaptation of UCT data DT210.3 • Construction of new processing chains, testing of data transmission to hub, monitoring & maintenance of operational processing, input to D220.1 • Establishing communications and planning with new receiving station (RS) users, configuring & ordering RS hardware/software, monitoring RS installation • Processing, serving & archiving of web based ChloroGIN Africa data, maintenance of ChloroGIN-Africa server, input to D240.1 • Review, recommendations for & provision of existing tools, input D250.1 • Updates on DevCoCast driven formats for MERIS/MODIS, resultant adaptation of UCT produced data • Contributed to D250.2; Updates to software and supporting documentation • Routine production of all GeoNetCast data, maintenance of operational processing facilities, updates to MERIS & MODIS reprocessing initiatives • All receiving station hardware delivered to respective partners. Support provided for installation and software/hardware trouble shooting. • On-going maintenance of UCT data websites • Regional Bilko exercises for the Northern Benguela (Namibia), the Gulf of Guinea (Ghana) and West Indian Ocean (Tanzania) are in development. • Provision and QC for data production • Further installation, maintenance and support for receiving stations - new DVB cards, replacement antenna, online & engineering support • Updates of training/processing software • Report on installation of new GEONETCast receiving stations (D230.1)
IMAR	• No activity planned in this WP
DMI	• No activity planned in this WP

EUMETSAT	• Coordination with PML on specification of the data to be added to the EUMETCast dissemination • Preparation of reception and diffusion of EAMNET data • Preparation of and routine monitoring of the dissemination (under DevCoCast) • Provision of the latest version of the Guidelines for the setup and maintenance for thematic GEONETCast stations • Update of the GEONETCast Product Navigator to include EAMNET data • Inclusion of all EAMNET data and change of channel for the transition from DevCoCast dissemination to EAMNET dissemination. Coordination with PML for ensuring data flow. • Continuation of the dissemination of EAMNET data and products towards Africa and associated monitoring
NERC	• Survey of tools requirement included in training survey • Lead partner for D250.1 Recommendations for development of tools. • Lead partner for D.250.2 Tools developed to meet recommendations • Improvements to Tanzania and Namibia lessons on use of flags and QC methods. Started new lesson on time series and temporal composites. • Delivery of 1 month's coastally processed delayed mode along-track 1 Hz altimetry test data for all EAMNET regions • Testing of Bilko software updates recommended by EAMNET, including limited batch processing capability. Follow-up advice on software and data processing to users from past EAMNet courses.
UDSM	• No activity planned in this WP • Contributed to D250.2; Updates to software and supporting documentation
UG	• No activity planned in this WP
MF-CMS	• Contribution to the data review of data relevant to marine and coastal production in Africa: SST and scatterometer products from SAF-OSI and MyOcean (D210.1)
NIOF	• Setting up and installation of EUMETCast reception station system and management of the software and data received

Institute	WP 300
PML	• Contribution to D340.1; Lectures and hands-on exercises for use in the MSc unit module • Compiled D320.1/D320.3/D350.1 report using partner contributions from UG, UDSM and UCT. • Review of all WP300 Deliverables
UCT	• Review of training needs, courses & materials, lead D310.1 • Implementation of African Op Oceans training course June 2011 (D340.2) • Design M.Sc. modules, Lead D330.1 • Development of lectures, exercises, material for M.Sc. module (D340.1) • Support for existing professional training courses and training of trainers (D320.2 and D350.2a) • July 2011 Operational Oceanography W/S at UCT, planning for UG & UDSM regional courses, planning for JRC Ocean Colour-Africa course September 2012 • Development of lecture and practical material by a team of EO experts comprised of 3 senior scientists, 4 mid-level scientists and 5 junior-level scientists (PhD students), to produce 60 hours of EO content for implementation as an MSc module. Presentation of materials during the UCT Applied Marine Science EO module and the regional Operational Oceanography Workshop. • MSc module materials distributed to course participants on DVD's and also made available via the PML EAMNet website. • Lead partner for D340.1; Contribution to D340.1; Lectures and hands-on exercises for use in the MSc unit module • Training at Ghana (March 2012), Tanzania (August 2012) and Morocco (October 2012) combined JRC training course, including D320/350 report • Support for M.Sc. module implementation Ghana & Tanzania • Contribution to delivery of Autodidactic version of the MSc modules (D350.3)
IMAR	• No activity planned in this WP
DMI	• No activity planned in this WP
EUMETSAT	• No activity planned in this WP

NERC	• Contribution to design and analysis of user survey and review of training needs. Input into D310.1 • Input into MSc course content of lectures and practicals • Making recent lessons available for the course, and planning delivery of altimetry component. • H. Snaith / P. Cipollini prepared altimetry lecture and practical for the UCT course, delivered by H. Snaith • Lectured at Ocean Colour Africa in El Jadida, Morocco. Delivered and taught computer practicals adapted for the course. Data/software support for mini-projects. • Lectured at University of Ghana training course. Delivered and taught updated computer practicals for the same course. • Development of background information and model answers for autodidactic version of the hands-on computer practicals. • Lead partner for D350.3 Autodidactic version of the MSc modules • Provided annotated altimetry and ocean colour lectures for the autodidactic version of the MSc module • Report on D350.3 Autodidactic version of the MSc modules • Set up an EAMNet Africa Prize for autodidactic lesson development based on African examples in collaboration with the ESA LearnEO! lesson writing competition.
UDSM	• Review of existing marine training structures, review the existing curricula on EO in East African Universities, identify training needs, tools and expertise through questionnaire surveys sent to various institutions and results reported during the EAMNet meeting in Addis Ababa (25-29th October 2010). • Development of a training tool for analysis of SST data and predicting coral bleaching using ILWIS software at ITC Netherlands (6-18 Feb 2011). • Establishing synergy between AMESD and EAMNet project activities in East Africa • Attended the operational training course at UCT (June 2012) • Working on SST data to acquire expertise on the use of open source software tools such as Ilwis and Bilko. • Restructuring of EO course modules at UDSM; limited material from the new MSc module infiltrated in the current MSc courses at UDSM during the academic year 2011/2012 but further infiltration to be undertaken after revision of the entire UDSM course curriculum for the M.Sc. by Coursework and dissertation programme (on-going). • Invitation of trainees from Kenya, Eritrea, Uganda, Mozambique, Tanzania Mainland, Seychelles and Comoros to attend the Regional training course conducted in Zanzibar; Logistic arrangements for getting training support from UCT and NIOF; training conducted in August 2012. • Produced training reports (D320.1/D320.3/D350.1)

UG	• Review of marine training structures and development needs in line with; infrastructure, data processing, data sources and applications • Materials prepared for loading and display of images/multi-band images, Image histograms, colour maps/colour palettes, filtering methods, Image enhancement, Measure of biogeophysical algorithm, Image classification, Ocean colour data interpretation and Fisheries management support using remote sensing data • Had interaction with organizers and participants at the EO training held in UCT; formulated strategies how training could be adapted to the Ghana and later up-scaled to the West African region • Provided support with review of training resources and needs • Liaised with UCT course organisers, reviewed selection of course material for 2-week training in Ghana and incorporated new material in the course schedule • Development of course lectures and identification of guest lecturer; development of relevant hands-on expertise in data processing and analysis; and implementation of course module in the University of Ghana • Provided support for implementation of course module in the University of Ghana • Provided IT support with configuration of server at the Remote Sensing laboratory; networking of system to enable access by undergraduate and graduate students using DevCoCast facilities for the project work • 2-week training course implemented in the University of Ghana. • Provided support with 2-week training course implemented in the University of Ghana. Was responsible for carrying out daily task with printing, data management, contacting participants, ensuring smooth and liaising between Dr. Wiafe all other service providers. • Provided IT support with configuration of server at centre used for the implementation of the course module. Assignment included returning facilities back to the Remote Sensing laboratory and re-configuring all systems back to original state. All to ensure that DevCoCast system is running as originally installed. • Guest lecturer for habitat mapping • Guest lecturer for shape detection using SAR • Training needs in Ghanaian universities assessed • Curricula of Department of Marine and Fisheries Sciences reviewed • Two training courses completed in 2012 and 2013 • Dr G. Wiafe has maintained active contact with NANO group of NF-POGO to support their regional program • Workshop report with participants feedback submitted (2 reports) (D320.1/D320.3/D350.1) • Detailed course structure developed by UCT adapted and implemented by UG for the 2 training workshops • Lectures in the form of PowerPoint presentation and hands-on training materials available • 1st & 2nd Reports on EAMNet Training Workshops • George Wiafe and Napoleon Addison attended the UCT organised during FY2 • Bilko tutorial on upwelling of the Gulf of Guinea
MF-CMS	• Hosting targeted fellow at CMS: Dr Wahid Moufaddal from NIOF for three weeks in May 2013.
NIOF	• No activity planned in this WP • Development of course lectures, hands-on and educational materials for the Training Workshop on "Coral Reef Monitoring and Operational Oceanography" Delivered / presentation of series of lectures to a total of 20 trainees from different African countries in , Zanzibar, Tanzania during 13-24 August 2012

Institute	WP 400
PML	• Lead WP400 • Coordination and delivery of open fellowship programme. • Organisation of open fellow's travel and subsistence payments consisting of 15 fellows over 3 calls, 1 each year of the project. • Assimilation of reports from open fellows and supervisors and creation of deliverable 420 • Assimilation of reports from targeted fellows and supervisors and creation of deliverable 410 • Hosting of 4 targeted fellows and 2 open fellows at PML
UCT	• Christo Whittle targeted fellowship placement at PML • Andy Rabagliati targeted fellowship at PML August - September 2011 • Hosting targeted fellows at UCT (Moto, Johnson) • Hosting open fellows at UCT (Brice, Agboola, Biche, Rabary, Titocan, Prince)
IMAR	• Acquisition of EUMETSAT equipment and software for satellite reception and processing / server improvement • Updates of web materials for online models. Development of models using a Software as a Service (SAAS) approach on the Insight Maker platform • Presented potential fellowship opportunities to partners at the 2012 annual project meeting. • Hoped to host a fellow during the final year of the project and planned a placement for a fellow from the University of Ghana but his visa was not accepted in time. • Integration of remote sensing and offshore aquaculture
DMI	• To prepare materials for hosting Targeted fellowship • Hosting and training of EAMNet partner visitor from NIOF: Training sessions in different fields were setup for the trainee Maged Hussain (NIOF) by DMI staff. The training included retrieval of satellite altimetry data and application of a surface wave (WAM) model for the SE Mediterranean shelf and the Nile delta.
EUMETSAT	• No activity planned in this WP
NERC	• A. Shaw hosted J. Amollo from Kenya Met Dept. Taught programming skills and technologies for analysis of tidal cycles and variability in TG and altimetry. • Hosted Y. Shaghude from UDSM for 2 weeks to work on development of computer practicals.
UDSM	• Avelino Langa targeted fellowship placement at UCT (May, 2011) • Siajali Pamba targeted fellowship placement at UCT (June/July 2012) • Kahitira Bwire targeted fellowship placement at University of Bangor (August 2012) • Yohanna Shaghude targeted fellowship placement at NERC (March 2012) • Joeline Ezekiel (a former earmarked EAMNet targeted fellowship) won a POGO fellowship with placement at PML (April – June 2013). • One targeted fellowship to NERC (Nyamisi Peter) cancelled due to delay in getting British visa.

UG	• Arrangements for targeted fellowship to visit Plymouth in May, 2011 • Beneficiary of a Targeted Fellowship to PML. • Receipt of a trainee from Senegal on Open Fellowship: training of recipient on EO data for resource management • Hosting open fellows at UG (Ousmane Diankha) • 1 targeted fellowship to PML completed in 2011; • 1 targeted fellowship planned to IMAR to be completed in June, 2013 (for development of expertise in front detection from EO data) but this had to be abandoned as the fellow's visa application was declined and there was insufficient time to reapply. • Targeted fellowship to Mauritius Oceanographic Institute completed in January, 2013: Engagement in application of EO for resource management; precursor for University of Ghana to implement MESA Project for ECOWAS
MF-CMS	• No activity planned in this WP • Hosting of Dr Wahid Moufaddal (NIOF) at the CMS for two weeks
NIOF	• 1 targeted fellowship to PML completed in 2011 for training on use of Beam software for analysis and processing of satellite ocean colour data as well as, utilization of satellite ocean-colour data for monitoring variability of the marine biological productivity off the Nile delta. • 1 targeted fellowship to DMI in Denmark, completed in 2012, for training on modelling and methods of analysis of hydrodynamic data • 1 targeted fellowship to El-Jadida, Morocco completed in 2012 for participation in the ocean colour training course: Methods and Applications of Ocean Colour Remote Sensing in Coastal and Regional Seas • 1 targeted fellowship to CMS-MF in Lannion, France, completed in 2013, for training on management of the EUMETCAST reception station system and data received.

Institute	WP 500
PML	• Lead on WP500 • Assimilation of articles and publication of 12 EAMNet newsletters to provide updates to the network on project progress and external news items of relevance. • Production of articles for inclusion in the newsletter • Creation of deliverable 510.1 and 520.1 • Creation and on-going updates and maintenance of EAMNet dedicated website to ensure an informative and useful platform for dissemination of EAMNet news and activities to the general public and partners. • Support for organisation of annual meetings. • Participation at AARSE 2010 and AARSE 2012 • Participated in all annual project meetings and prepared minutes for circulation to partners • Dissemination and awareness raising of EAMNet at conferences and events • Created project leaflet and short film • Creation of Alumni Forum
UCT	• Contributions to project website content • Articles contributed to newsletters • Organisation of AARSE 2010 special sessions & associated EAMNet/DevCoCast sessions, logistics for travel & support for African attendees

	• Organisation of annual project meetings • Organisation & logistical arrangements for AARSE October 2012 sessions • Dissemination and awareness raising of EAMNet at conferences and events
IMAR	• Dissemination of EAMNet through the National Science Foundation of Portugal, targeting the PALOP nations in Africa (Portuguese speaking nations), i.e. Angola, Mozambique, Guinea Bissau, Cabo Verde, and São Tomé e Príncipe. • Newsletter article (1200 words): Remote sensing as a tool for Integrated Coastal Zone Management – Lessons learnt from the SPEAR project and applications in Africa through EAMNet. • Abstract: “Remote sensing as a tool for Integrated Coastal Zone Management – Lessons learnt from the SPEAR project and applications in Africa through EAMNet” was prepared, submitted, and accepted for the AARSE conference in Addis Ababa. Unfortunately, it was not possible for IMAR to be represented at the meeting, and the abstract was subsequently developed for WP250 to ensure appropriate dissemination. android development of oceanographic applications and GIS and image processing for Newsletter 3 and 4 (April 2011 communication) • Newsletter article (700 words): Aquaculture modelling and remote sensing for EAMNet targeted fellowship (Newsletter issue 11) • Presentation of IMAR partner activities for WP410 (exchange of personnel) • GIS and image processing • Participated in annual project meetings in Plymouth, Antwerp, El Jadida and Cape Town • Dissemination and awareness raising of EAMNet at conferences and events
DMI	• To promote EAMNet in relation to MyOcean and GEONETCast • Contributed an article to EAMNET in 2011, on the experience of cooperation with developing countries on capacity building of operational oceanography • Participated in annual project meetings in Antwerp and Morocco • Dissemination and awareness raising of EAMNet at conferences and events
EUMETSAT	• Contribution to the EAMNET newsletter with information on GEONETCast • Communication of EAMNET on EUMETSAT website • Inclusion of a slot for EAMNET presentation in 9th EUMETSAT User Forum in Africa + coordination for EAMNET participation • Information on the change of channel. • Information about EAMNET provided to DG DEVCO during preparation and inception of the MESA project • Participated in annual meetings in the Plymouth and Antwerp
NERC	• Attended AARSE Conferences, Addis Ababa 2010 and El Jadida 2012. • Liaison with UNESCO, IOC, ASCLME and Humanitarian NGOs. • Participated in all annual project meetings • Dissemination and awareness raising of EAMNet at conferences and events • Presentation on development of hands-on Earth Observation training resources for Africa, at IGARSS 2012 and AARSE 2012
UDSM	• Submitted articles for EAMNet newsletter on a regular basis • Participated in all annual project meetings • Participated in the AARSE meeting on regular basis (Oct 10 and Oct 2012) and delivered oral/poster presentations. • Participated at WIOMSA symposiums on regular basis also intending to join the next meeting in October 2013. • Co-authoring of an article which was published on the ITC website • Logistical arrangements to facilitate the preparations and submission of

	Abstracts/manuscripts for presentation to the 8th WIOMSA symposium by UDSM EAMNet targeted fellowship scholars Dissemination and awareness raising of EAMNet at National and Regional forums
UG	- Submitted articles for EAMNet newsletter on a regular basis - Participated in all annual project meetings - Junior personnel attended AARSE 2010 conference
MF-CMS	- Participated at AARSE conference and AARSE 2012 - Attended annual project meetings in Plymouth, Antwerp, El Jadida and Cape Town - Translation in French of a part of the website and the fellowship announcements. - Submitted articles for EAMNet newsletters on a regular basis
NIOF	- Submission of two articles for publication in the EAMNet newsletter - Attendance and participation in the coastal and marine session of the AARSE 2010 conference (October, 2010), AARSE 2012 in El-Jadida, Morocco, as well as EAMNet meeting with an oral ppt. - Translation of EAMNet Open Fellowships calls into Arabic to be published on the project website - Translation of several pages of the original content of the project website into Arabic to provide multilingual versions of key pages of the site - Participated in annual project meetings in Addis Ababa, Antwerp, Morocco and Cape Town

Institute	WP 600
PML	- Lead for WP600 - Lead for collaborative D600.1 report: Plan for engagement with the Lisbon process and nature of user consultation - Lead for collaborative D600.3 report: Final recommendations for the EU-AU Action Plan - Presented draft report conclusions at GMES-Africa meeting Mombasa 2012 - Lead discussions on GMES & Africa approach at Annual Meetings - Consolidated consortium input to Marine and Coastal draft action plan via aquaknow website (2010) - Collaboration with BRAGMA - Engagement, recommendations, road map development with GMES-Africa around Mombasa 2012, GEO, GOOS and OceanSAfrica
UCT	- To participate EAMNet Kick-off meeting - Input to Marine and Coastal draft action plan, input to D600.1 - Consultation with DST, BRAGMA, African community through OceanSAfrica, and GMES-Africa report authors - Engagement, recommendations, road map development with GMES-Africa around Mombasa 2012, GEO, GOOS and OceanSAfrica - Contribution to D600.3 Final recommendations for the EU-AU Action Plan
IMAR	Participation in Annual Meeting discussions of GMES & Africa approach
DMI	Participation in Annual Meeting discussions of GMES & Africa approach

EUMETSAT	• Provided information on EAMNET during JEG-8 meeting in Brussels (September 2010) • Participation to annual meeting. Contribution to secure visibility of EAMNET during the GMES Africa Coordination Group meeting at end of January • Special session at the 10th EUMETSAT User Forum in Africa on GMES Africa, with a presentation of EAMNET • Contribution to discussion around GMES & Africa and link with MESA programme
NERC	• Contribution to discussion around GMES and Africa • Contribution to D600.3 Final recommendations for the EU-AU Action Plan
UDSM	• Participation of UDSM/IMS leadership at IOC-UNESCO meetings on a regular basis. Participation of the Western Indian Ocean Data Buoy Cooperation Panel (DBCP) workshops on a regular basis • Participation at Pre-regional Climate Outlook Forums for the Greater Horn of Africa experts meeting in February 2013 and expecting to participate in the forthcoming meetings on a regular basis. • Participation at the National workshop on mainstreaming climate change adaptation into coastal and marine development.
UG	• As the co-ordinator of the GCLME Productivity and Biodiversity Centre, Dr Wiafe is in regular communication with the 16 country representatives on application of EO data in the region • Contribution to the Final Draft of the GMES Africa document for AUC-EC
MF-CMS	• Review and comment GMES & Africa action plan
NIOF	• Contribution to section 6 (coastal and marine areas) of the annual GMES and Africa Action Plan report • Contribution to EU-AU Action Plan for GMES Africa through minor editing of the intermediate draft of the GMES and Africa marine and coastal chapter.

OL10 <http://openlayers.org/>. Visited 24/08/2010.

WFS: Web Feature Service Implementation Specification, OGC Document 04-094 - http://portal.opengeospatial.org/files/?artifact_id=8339.