Proposal full title:	Science based remote sensing services to support REDD and sustainable forest management in tropical region
Proposal acronym:	ReCover
Type of funding scheme:	Collaborative project, Small or medium-scale focused research project
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List of Acronyms

ABC	Allometric Biomass and Carbon (Factors Database)
ALOS	Advanced Land Observation Satellite
ASAR (Envisat)	Advanced Synthetic Aperture Radar
Aster	Advanced Spaceborne Thermal Emission and Reflection Radiometer
AVNIR-2 (ALOS)	Advanced Visible and Near Infrared Radiometer
AWiFS	Advanced Wide Field Sensor
CA	Consortium agreement
CBERS	China-Brazil Earth Resources Satellite
CEOS (ALOS)	Committee on Earth Observation Satellites, file format
COP	Conference Of the Parties
CORDIS	Community Research and Development Information Service
CORINE	Coordination de l'Information sur l'Environnement (land cover)
COTS	Commercial Off-The-Shelf
CSW	Catalogue Service for the Web, OGC standard
DEM	Digital Elevation Model
DRC	Democratic Republic of Congo
DSM	Digital Surface Model
DTM	Digital Terrain Model
DUE	Data User Element
EC	European Commission
Envisat	Environmental Satellite)
EO	Earth Observation
ERS(-1)	European Remote Sensing satellite
ESA	European Space Agency
ETM (LANDSAT)	Enhanced Thematic Mapper
EU	European Union
FAO	Food and Agriculture Organisation
FBD (TerraSAR-X)	Fine Beam Dual
FCT (GEO)	Forest Carbon Tracking Task
FP2, FP7	Framework Programmes
FRA	Forest Resource Assessment
GEO	Global Earth Observation - intergovernmental coordination entity
GEOSS	Global Earth Observing System of Systems
GFC	Guyana Forestry Commission GFC
GHG (AFOLU)	Greenhouse Gases (in Agriculture, Forestry and Other Land Uses)
GIS	Geographic Information System
Globcover	Project on Global Land Cover
GMES	Global Monitoring for Environment and Security
GOFC-GOLD	Global Observation of Forest and Land Cover Dynamics
GSCDA	GMES Space Component Data Access
GSE	GMES Service Element
HR	High Resolution
IEEE	Institute of Electrical and Electronics Engineers
IMP (ASAR)	Precision Image
InSAR	Interferometric Synthetic Aperture Radar
INSPIRE	Infrastructure for Spatial Information in the European Community
IP	Intellectual Property
IPCC	Intergovernmental Panel on Climate Change
IPR	Intellectual Property Rights
IRS	Indian Remote Sensing satellite
IS4 (ASAR)	Image Swadth (imaging mode)
ISPRS	International Society for Photogrammetry and Remote Sensing

IUFRO	International Union of Forest Research Organizations
JAXA	Japan Aerospace Exploration Agency
JERS	Japanese Earth Resources Satellite
JRC	Joint Research Centre
JSR-168	Java Specification Request, standard on Portlet Specification
km	kilometre
KOMPSAT-2	KOrea Multi-Purpose SATellite-2, VHR optical satellite
LAI	Leaf Area Index
LANDSAT-5	Medium Resolution Earth Observation optical Satellite
LIDAR	LIght Detection and Ranging
MC	(Project) Management Comity
MERIS (Envisat)	MEdium Resolution Imaging Spectrometer
$Mg*ha^{-1}$	Biomass unit (megagram / hectare, or metric ton per hectare)
Modis	Moderate Resolution Imaging Spectroradiometer
MR	Medium Resolution
MSc	Master of Science
MSS (LANDSAT)	Multispectral Scanner
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
ND	Non-determined
NFI	National Forest Inventory
NGO	Non-Governmental Organisation
NIR	Near Infrared - optical image channel(s)
NOAA-AVHRR	National Oceanic and Atmospheric Administration - Advanced Very High Resolution Radiometer
OCG	Open Geospatial Consortium
OSFAC	Observatoire Satellital des Forêts d'Afrique Centrale
PALSAR (ALOS)	Phased Array type L-band Synthetic Aperture Radar
PDR	People Democratic Republic
PhD (Dr)	Doctor of Philosophy
PolInSAR	Polarimetric Interferometric Synthetic Aperture Radar
PRI (Envisat)	Precision Image
QA	Quality Assurance
Quickbird-2 (QB)	VHR optical satellite
R/D, R&D	Research and Development
REDD	The United Nations Collaborative Programme on **R**educing **E**missions from **D**eforestation and Forest **D**egradation in Developing Countries
RGB	Red Green Blue
SAR	Synthetic Aperture Radar
SBSTA	Subsidiary Body for Scientific and Technological Advice
SCC (TerraSAR-X)	Satellite Control Centre, file format
SLA	Service Level Agreements
SLC (SAR)	Single Look Complex
SME	Small and Medium Enterprises
SPA	FP7 Space Call (2009-2010)
SPOT	Satellite Pour l'Observation de la Terre
SRTM	Shuttle Radar Topography Mission
$t*ha^{-1}$	Tons per hectare, carbon sequestration unit
TBC	To Be Confirmed
TM (LANDSAT)	Thematic Mapper
TREES	Global Forest Resource Monitoring Project
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
VHR	Very High Resolution

WFS	Web Feature Service, OGC standard
WMS	Web Map Service
WP	Work package
WPS	Web Processing Service, OGC standard
WSRP	Web Services for Remote Portlets, standard
WWF	World Wildlife Fund

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1 Scientific and/or technical quality, relevant to the topics addressed by the call

1.1 Concept and objectives

1.1.1 Strategic reasoning of ReCover

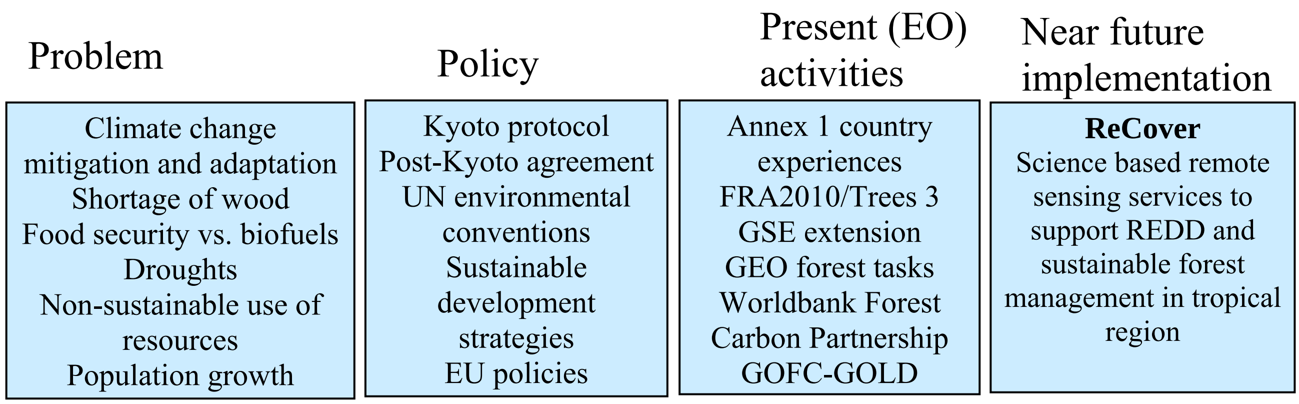


Figure 1. ReCover as a realizer of policies.

It is estimated that the world's forests store 283 Gigatonnes of carbon in their biomass (FAO 2005). Together with deadwood, litter and soil the total carbon content in forest areas account to one trillion tons. Due to the destruction of the forests, mainly in Asia, South America and Africa, approximately 1.1 Gt of carbon stored in forest biomass has been lost annually between 1990-2005. Out of this, majority has been emitted to atmosphere, which accounts to ~20% of all man-made carbon emissions (Stern 2006).

However, the reported figures of forest cover, biomass and forest carbon content contain considerable sources of error, especially those of developing tropical countries (Achard 2002, Grainger 2008). It is believed that the largest errors in the estimates of the terrestrial carbon balance result from uncertain rates of tropical deforestation but also the changes in biomass and carbon content are inadequately assessed in most of the areas below northern-mid latitudes (Houghton 2005, Eva et al. 2003, Fearnside & Laurance 2003). The Intergovernmental Panel on Climate Change (IPCC) has pointed out that "for tropical countries, deforestation estimates are very uncertain and could be in error by as much as ±50%" (Cited in Achard 2002).

Concern about foreseen climate change and the major role of forests in the global carbon cycle, have lead the international community to agree on policies and treaties such as the Kyoto Protocol of the UNFCCC. One purpose of these policies is to curb deforestation and forest degradation but also to ensure sustainable supply of fuel wood, timber, non-wood products and conservation of biodiversity. Higher reliability is expected of the forest resource information. The REDD (Reduction of Emissions from avoided Deforestation and Degradation) process that most likely will be a part of the post-Kyoto climate treaty will be a major driver for the development of effective climate change mitigation but it requires reliable methods for forest resource inventories. Deforestation and degradation of forest biotopes are major problems particularly in developing countries, where inadequate resources are available for forest protection.

Still today forest resources information and statistics are mostly based on field inventories and expert reporting. Remote sensing community is active in forest monitoring but their activities and the baseline forest inventory do not fully meet in terms of interoperability and information needs for new initiatives such as REDD. One of the main development needs is to make the match happen so that remote sensing techniques can improve the quality of operative forest monitoring and advance sustainable forestry. There is a general agreement that space-borne earth observation must have a key role in the implementation of REDD.

Several global and continental wall to wall land cover products from satellite data are available (Arino et al., 2008, Häme *et al.* 2001, Gallaun *et al*. 2009). The ground resolution of these products varies from 300 m to approximately 1 km. A global land cover mapping project using these data is ongoing Arino et al. 2008). The usual remote sensing data in such monitoring systems are either Landsat data of 30 m or coarser resolution Modis. Global digital image datasets of Landsat with 30 m resolution are available from around 1990 and 2000, and 2005 (Wulder et al., 2008). In the change monitoring domain, tropical deforestation and forest fires are monitored with satellite data. In Brazil the satellite based change monitoring is on operative stage (see http://www.obt.inpe.br/prodes/index.html).

The massive European contribution to support policy implementation is the 2.3 billion euro program GMES (Global Monitoring of Environment and Security), which is funded and managed in cooperation between the European Union and the European Space Agency ESA. The GMES is the European contribution to the GEOSS (Global Earth Observing System of Systems).

The international programs and organizations have launched projects to do the concrete implementation work. Ongoing or recent projects include TREES 3, FRA2010, GMES Service Element (GSE) Forest Monitoring and GSE Forest Monitoring Extension. The ReCover project will take one step ahead as the successor of the present projects by applying novel techniques and data types in image analysis and by further developing service accuracy, quality, and standardization (Figure 1).

The FAO has also responded to the known problems of the Forest Resources Assessments by launching a remote sensing survey. For the FRA 2010 the FAO is undertaking a global satellite image survey of forests to expand knowledge on land use change dynamics over time, including deforestation. The FAO remote sensing survey will use a systematic sample of available historical medium resolution data, *i.e.* 20 m to 30 m images (Ridder 2007) to obtain more accurate global and regional-level statistics.

In conjunction with FAO's FRA 2010 remote sensing survey, the European Joint Research Center is working on implementing the TREES III project that provides quantitative measurements and mapping of changes in forest resources for EU policies related to global environmental and forestry issues, with a focus on Eurasian boreal forests and tropical forests, including the Caribbean and Pacific regions. The approach is a similar sampling approach than for FAO's efforts but data interpretations vary and focus on land cover changes rather than land use changes as anticipated for the FRA survey.

The GSE Forest Monitoring Extension will provide services to support REDD in a selection of tropical countries. The focus is on the service development using state-of-the-art techniques for forest cover monitoring. The purpose of ReCover reflects the requirements of the work statement in SPA.2010.1.1-04 and is to develop novel services which go beyond the GSE Forest Monitoring and other parallel projects.

A number of barriers have to be crossed before the wide operative use of remote sensing is possible. The barriers are not only technological but also associated with inadequate capacity and training as well as need of policy development. Data analysis methods have to be continuously developed to improve the quality of the operative services, make them easier to the users and preferably decrease the service costs at the same time. Our project ReCover focuses on the technological development, reflecting the contents of the work statement, but the other aspects are considered throughout the whole study. A significant training effort is included and capacity building is supported among other things by visits of personnel of non-EU ReCover partners to partner organizations within the European Union.

The main technical and organizational development challenges are:

- **Solid statistical concept.** Presently the accuracy of remote sensing based surveys is variable (*e.g.* Heiskanen 2008) and the true meaning of the given accuracy figures is vague. A pressure for impressive results has sometimes led to reported accuracy figures that look unrealistic. In the long term this can be quite damaging to the operative application of earth observation when the true

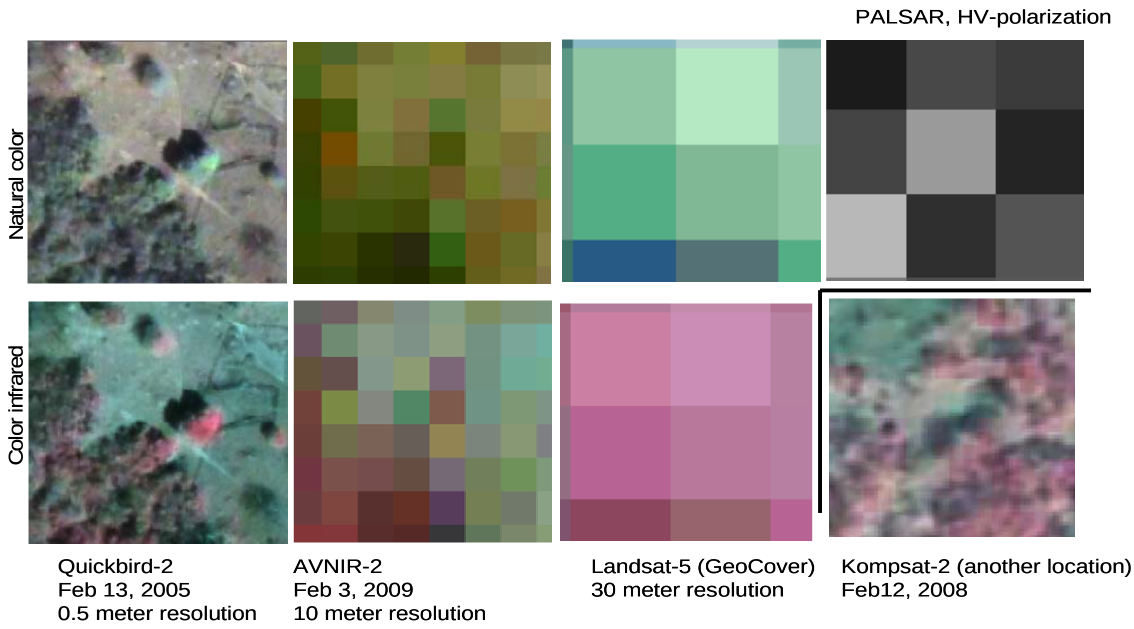


Figure 2. A 70 m by 70 m area from the same location in Lao PDR in different satellite images.

- capabilities of the techniques start revealing. A solid statistical concept has to be developed to derive comparable results on forest variables with the confidence intervals irrespective of the size or location of the area of interest or used remote sensing material.
- **Increase accuracy of principal data.** The highest spatial resolution that has been applied in forest application has been usually 20 m to 30 m of Landsat or Spot. The principal data are too unreliable if data with better accuracy are not available either from ground or from satellite. This makes it very difficult to evaluate information content of the results. As can be seen in Figure 2, already 10 m resolution is too coarse to reliably identify the land cover class. Preferably a sub-meter resolution is required. A procedure is needed in which reliable principal data on forest variables are available. It is hypothesized that these data can to great extent be available from Very High Resolution (VHR) satellite images (Figure 3).
- **Biomass.** Inventory of biomass and biomass change is required to understand the carbon balance of forest and it is thus also an integral part of the REDD process. Biomass through the growing stock tree volume is being successfully mapped using space-borne data in the boreal zone. In the tropical region only few studies have been carried out. Therefore clear evidence of the possible quality for biomass assessment is still not possible. In general, the biomass estimation is still in a research stage.
- **Degradation.** It is commonly acknowledged that estimation of forest degradation is a key issue in the reduction of emissions and therefore degradation is included in the REDD process. However, the monitoring techniques of degradation are completely un-established and even the whole concept of degradation is unclear (UNFCCC 2008). With Landsat type data degradation may be hard to monitor due to too coarse spatial resolution (REDD Sourcebook 2009). Novel remote sensing techniques to monitor degradation are urgently needed. The techniques should be flexible enough to adapt to the evolving definitions of degradation. Monitoring of degradation is closely linked with the biomass monitoring.
- **Change.** Avoided deforestation and forest degradation requires definition of the baseline, *i.e.* the trend what would occur if recovery were not taken. The trend estimation requires monitoring of change. Although change monitoring is one of the most obvious applications of space-borne remote sensing the change mapping methods have been rather primitive (post classification comparison) or academic research. More sophisticated but easy-to-use and reliable methods for operative change mapping have to be developed.
- **Potential of radar.** In the monitoring applications information is needed at frequent intervals. Synthetic Aperture Radar (SAR) has been seen as the answer to obtain information whenever needed. However, the utilization techniques of SAR are still in the development stage. SAR has a

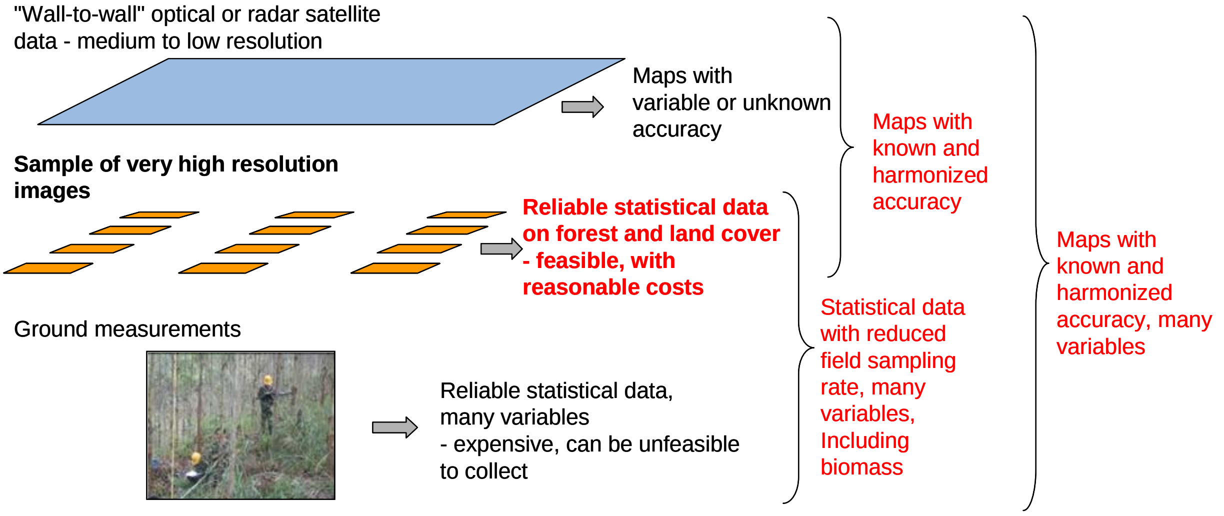


Figure 3. A concept to combine different data sources in forest monitoring.

- significant potential in forest monitoring but also several limitations have been identified (Rauste 2005, Häme et al. 2009). The role of SAR in the forest applications with a particular focus on REDD related applications has to be further studied.
- **Interactive analysis.** Remote sensing projects usually produce thematic maps using numerical image interpretation. The maps are somehow validated but the user has to take them as they are. Approaches should be developed in which a human expert can interactively influence the mapping process, however in such manner that the objectivity of the mapping is ensured. For instance, in TREES-3 project country experts review the image interpretation results of map polygons and modify the interpretation when necessary. Although such approach may not be directly applicable in a monitoring system of objective information source requirements, interactive image analysis methods should be developed to ensure the quality of the results.
- **Not only REDD but sustainable forest management.** The REDD process boosts the development of remote sensing methods for tropical forest monitoring because an objective monitoring system is required to verify avoided deforestation and degradation. It has been realized, however, that REDD has to be part of wider development of the forest management system to support also sustainable utilization of the forest resources. The forest monitoring systems that are developed for REDD should serve also the forest sector more widely, *i.e.* the REDD+.
- **From growing stock volume to carbon.** There are big uncertainties in the Carbon estimation. In the field in practical work the reference data for biomass is the growing stock volume (tree stem volume). The tree volume is transformed with equations to dry total biomass of which approximately one half is carbon. The transformation is however unreliable due to lack of experimental data.
- **Standardized services.** The remote sensing service industry has been lacking of standardization of production and product quality. Variable formats, accuracy figures and accuracy evaluation procedures may confuse candidate users and limit the utilization of earth observation techniques. More standardized production is required to achieve the user acceptance and consequently maximum user benefit from remote sensing.
- **Capacity building.** Space-borne earth observation is not a well known technique in most operative organizations in the industrial countries. In many developing countries earth observation is used sometimes more intensively. However, the use may be limited to separate projects and in-house earth observation capabilities are low. Significant attention has to be paid on the capacity building activities in the developing countries.

The objective of ReCover is to develop beyond state-of-the-art service capabilities to support fighting deforestation and forest degradation in the tropical region. The pilot service capabilities mean provision of *a monitoring system of forest cover and forest cover changes and biomass including a robust accuracy assessment.* The capabilities are based on utilizing earth observation and *in-situ* data. The earth observation data are primarily from space-borne instruments, which enables development of harmonized services.

The service development is controlled by specific user requirements that are expressed through Service Level Agreements (SLA) between the ReCover consortium and six users. The SLA's directly guide the scientific work in the project. The services prepare particularly for the implementation of the post-Kyoto climate treaty and the REDD+ process but they also contribute in the development of sustainable forest management in general.

Service roll-out and expansion to the community outside the project and present pilot users is a key activity of ReCover. The outside community includes but is not restricted to TREES-3 project, GSE Forest Monitoring Extension, FRA, and GEO. An important part of the study is to evaluate the cost/accuracy relationship of the alternative services.

Although ReCover provides actual services, their scientific viewpoint that reaches beyond the state-of-the-art techniques is the leading baseline of the study. This differentiates ReCover from the several parallel activities.

The six users from five countries are REDD forerunners. Particularly the Mexican users CONAFOR and PMC and Brazilian INPE have participated in the creation of the global REDD capabilities as key actors. The Guyana Forestry Commission and Fiji Forestry Department that are main organizations for REDD in their home countries represent progressive governments that want to improve their forest management and utilize remote sensing for REDD. OSFAC, the GOFC-GOLD network for Central Africa, widens the user sector to NGO's and its participation in ReCover secures that the information is disseminated to all the relevant actors of REDD. The humid tropical forest of the Congo basin is the second largest in the world. More detailed description of the users is given in Annex 5.

1.1.2 Specific objectives

The detailed objectives of ReCover are derived from the challenges. ReCover project will

1. **Significantly expand the network of GMES users and services in tropical regions on three continents** (Latin America, Africa, South Pacific)
2. **Evolve a statistical concept for the remote sensing based forest monitoring system**. The concept means that for the forest cover type and other variables accuracy figures and confidence intervals can be computed in a manner that is transparent and understandable.
3. **Take care of that the basic data in the inventory chain is as accurate as possible.** This means using ground reference data and a sample of VHR satellite data when applicable. In the monitoring of historical change new data cannot be naturally collected and archived VHR data are only available from this decade. The results of the estimation are compared whenever possible with the information from external data sources such as forest statistical data. In all cases the statistical concept is followed.
4. **Create novel methods for biomass estimation.** The methods developed and tested include use of combination of VHR optical data, space-borne radar data, optical wall-to-wall data, airborne laser scanner and other data and field data. The methods aim at achieving of accuracy that is required for Tier level 3, *i.e.* application of disaggregated national inventory-type data for carbon pool estimation. Alternative approaches are tested and compared.
5. **Have a special focus on the monitoring of forest degradation.** It requires among other things inclusion of data with higher resolution than what has been the practise in earlier forest monitoring activities. Degradation monitoring is closely associated with biomass estimation and change detection.

6. **Create and implement a forest change monitoring system** including computation of confidence intervals for the changed areas.
7. **Investigate the potential of present and future radar and optical missions** (*e.g*. the Sentinels) and techniques and give justified recommendations on the roles of different earth observation data sources in the tropical and other forest surveys.
8. **Consider the role of a human interpreter in the value chain** and generate different value adding scenarios for the varying user communities.
9. **Consider inclusion of all forest variables that are needed for advancing sustainable forestry** in the value chain. The mindset in the project is to promote sustainable forestry in the manner that fulfils the requirement of REDD.
10. **Apply state-of-the-art methods to transform the forest variables into carbon sequestration figures**. The research in this work is not focusing on the development of the transformation equations but the best knowledge available is utilized. Top knowledge on the issue is available within the consortium.
11. **Develop standardized service chains**. All the services are delivered through the same chain with thematic and technical quality control procedures. The chains will be INSPIRE compatible although the services will be applied outside the European Union.
12. **Contribute in capacity building in the user countries**. The capacity building will be implemented among other things by receiving staff members of user organizations to the premises of service providers for longer term training. Naturally the on-site training and user federation is an important part of the project.
13. **Evaluate the feasibility and cost/benefit of the alternative service chains**.
14. **Prepare a plan and take concrete actions on outsourcing and roll-out of the services**. Service roll-out is implemented through road shows that will be done particularly in African countries. Also the information of ReCover will be communicated to the parallel projects and to the wider communities including general public.

1.1.3 Relevance of ReCover to Work Programme Objectives

The objectives of ReCover respond to the description of the requirements of SPA.2010.1.1.-04 (C) Forest Monitoring. *Scientific development of new service capabilities* is realized particularly through the application of a statistical approach in all the services, from the combination of VHR and lower resolution imagery, radar image and numerical change analysis techniques. The forest variables of particular interest are biomass and forest degradation. It is recognized that definition of forest area (using the crown closure) and main forest type are part of the biomass estimation procedure. We will estimate the crown closure as continuous variable which makes it possible to adapt the services to different forest definitions.

The operationalization of novel laboratory techniques and scientific methods to implement European policy and GMES objectives is implemented by serving true users as described in the service level agreements that are attached in this proposal. The actual services also guarantee that they are *validated in a service environment*.

All the study sites and our six users are outside Europe. It ensures a *user-driven approach* that *broadens the applications to areas outside Europe*. The methods to be developed will be generic and scalable enough to apply the concepts to be developed also over *global coverage*. In addition to the six users, we have three consortium partners outside Europe. These highly qualified *third party* partners with local expertise contribute to the *scientific excellence* of the project and also increase the impact of the project by improving the possibilities to service roll-out and outsourcing.

Project coordinator VTT was a key member of GMES Service Element project Forest Monitoring having a service case in the tropical region. Two other partners of the consortium, University of Freiburg and GMV were members of the same consortium. The coordinator has a service case in Lao PDR in the extension project of the GSE Forest Monitoring. VTT is also participating in the GMES project Geoland 2 and University of Freiburg was a partner in Geoland 1. Participation in these consortia ensures that ReCover will build on the achievements in the other services. However, a more formal cooperation setup with the GSE Extension and other most relevant projects such as TREES 3, FRA, GEO Forest activities will be implemented. The cooperation arrangement is facilitated through Global Observations of Forest Cover and Land Dynamics (GOFC-GOLD) that is represented in the consortium and is a formal member in the GEO forest related tasks and FAO's FRA 2010 survey.

ReCover will develop standardized and validated *prototype services* that are delivered to the user according to the SLA's that the user has defined. The SLA's include the list of products to be delivered and user's request on the accuracy of the results. A delivery that fulfils the SLA's requirements indicates the *added value* of the service to the user. Same standardized *service architecture* is applied to all the products before delivery. Resources are assigned to capacity building to enable service integration *into current user practices*.

The available satellite and *in-situ* data (either at archives or already at the premises of the consortium members) are listed in this proposal as well as the requested new data. As it comes to the provision of data, the ReCover consortium relies mainly on the Data Access Grant of ESA. An ESA representative was consulted about the general principles during the project preparation phase. Back up plan for the non-availability of the data is presented.

The services are validated in respect to result accuracy by applying a statistical approach in the services and in respect to service general quality and usefulness. The training activity that is associated with all the services will be accompanied by *user assessment*.

1.2 Progress beyond the state-of-the-art

The state of the art for monitoring and measuring green house gas emissions from deforestation and degradation is extensively described in the so called source book of the ad-hoc REDD working group of the GOFC-GOLD (Global Observations of the Forest and Land Cover Dynamics). In this book (GOFC-GOLD Sourcebook 2009), a set of definitions of forest is provided. For instance, in the context of the Kyoto protocol, participating countries can adopt limits on forest area (0.05 … 1 ha), potential to reach a minimum tree height at maturity of the trees (2 … 5 m), and minimum crown cover (10 … 30 percent). As these definitions follow a common view widely accepted in the IPCC process, the applicable forest definition has to be used for the forest *vs.* non-forest classification in project ReCover. In addition the important terms of deforestation and degradation are defined in the REDD sourcebook.

IPCC guidelines use so called tiers for the assessment of emissions in the context of REDD (GOFC-GOLD Sourcebook 2009). Tier 1 uses IPCC default values (i.e. biomass in different forest biomes, carbon fraction etc.). Tier 2 requires some country-specific carbon data (i.e. from field inventories, permanent plots). Tier 3 uses highly disaggregated national inventory-type data of carbon stocks in different pools and assessment of any change in pools through repeated measurements (permanent plots) or modelling. Moving from tier 1 to tier 3 increases the accuracy and precision of the estimates, but also increases the complexity and the costs of monitoring. In an ambitious research project like ReCover, tier 3 should be the level to aim for.

The following chapters describe the state of the art separately for the product groups forest cover, forest cover change, forest degradation, and forest biomass. Accuracy and other performance figures are cited from literature. It must be kept in mind that these figures are not meant to be comparable from study to study because the study site type and other conditions vary widely between studies. For each product group the development beyond state-of-the-art is outlined 1) for the main approach adopted initially in the products to be delivered to users, and 2) for more experimental sensors and methods that will be available during or after the ReCover project. The products to be delivered to users are not made dependent on these sensors and methods initially. The purpose of the sections titled "development beyond state-of-the-art" is to outline ways that – via research in project ReCover - improves on the state-of-the-art in such a way that the objectives for ReCover products – as derived from the needs of the REDD process and defined by the users in SLAs and in other contexts – are met well and in a cost-effective way.

1.2.1 Forest cover

Challenges in forest cover mapping

The following challenges that were listed in the previous section "Strategic reasoning of ReCover" are particularly relevant to forest cover mapping: *solid statistical concept, increase accuracy of principal data, potential of radar, interactive analysis, not only REDD but sustainable forest management, standardized services, and capacity building.*

State of the art in forest cover mapping

The objective of forest cover mapping in the REDD context is to discriminate between areas where the applicable criteria of forest (e.g. canopy closure higher than 10 percent and average tree height over 5 m) are fulfilled and those where these criteria are not.

The REDD source book (GOFC-GOLD Sourcebook 2009) describes the state of the art in the monitoring of deforestation and degradation using remote sensing data. The methods refer mainly to optical data. Visual interpretation and digital classification methods for optical data are described. The cases include examples of wall-to-wall coverage and sampling-based approaches. For the forest/non-forest mapping, accuracies between 80% and 95% are reported for optical data sets. Multi-sensor approaches or mapping approaches based on radar data are not reported in (GOFC-GOLD Sourcebook 2009) for the forest non-forest classification.

In scientific literature in general, tropical forest cover has been studied using optical imagery (DeFries et al. 2005, 2006, UNFCCC 2006, Mollicone et al. 2007, Achard et al. 2002). A whole range of resolutions is used to monitor forest cover and degradation from optical sensors, from MR (MODIS, SPOT Vegetation, MERIS) to HR (Landsat, SPOT HRV, AWiFs LISS III, CBERS) and VHR (Ikonos, Quickbird) (Myers Madeira 2008). Continuous forest variable estimation was carried out in Astola et al. (2004) based on feature extraction and segmentation of VHR satellite images.

SAR backscatter has also been used in forest cover mapping. Forest cover in the entire French Guiana was mapped in C-band SAR from ENVISAT ASAR (Häme et al. 2009). A classification accuracy of 96 percent was estimated using an idependent set of sample points that was not used in the construction of the classification models. L-band SAR penetrates forest canopy and has a better estimation of wooden components as well as enhanced contrast between forest/non-forest (Almeida-Filho et al., 2007). SAR backscatter has been used in forest cover mapping also by De Grandi et al. (2000), Fransson et al. (2007, 2008), Langner et al. (2008), and Almeida-Filho et al. (2009). Repeat-pass SAR interferometry in short repeat cycles can assess clear-cut areas greater than 4 ha with 95% accuracy (Askne et al., 2003). Interferometric SIR-C shuttle SAR at L band over tropical rain forest reached 5m RMS difference in inferred topographic height between forest and clearings (Rignot, 1996).

SAR coherence images under winter conditions are more sensitive to changes in woody biomass than backscattering. Coherence images can be used over large areas - Gaveau et al. (2003). Winter coherence images with summer L band HV images can delineate and classify forest land from other classes (Thiel et al. 2009). Some of these techniques requiring specific winter conditions may not apply in tropical areas.

Airborne lidar data has proved useful for forest / non-forest boundary delineation (GOFC-GOLD 2008), crown coverage (Wang et al. 2008) and forest gaps mapping (Dees et al. 2006). Straub et al. (2009) report a 97% accuracy for forest delineation from lidar. Falkowski et al. (2009) estimated forest cover from lidar with more than 95% accuracy. A combination of lidar and RGB photos were used in Switzerland with mixed land-use categories (Wang et al. 2007).

Development beyond the state-of-the art in forest cover mapping in ReCover

A recent study (pilot study in forest cover and forest degradation mapping in Laos, funded by the Finnish Foreign Ministry) paved the way for multi-sensor stratified sampling approach and will be brought further in ReCover. Intelligent ways of utilising EO data from a wide set of sensor types and sensor resolutions are combined in mapping processes that are based on sound statistical design principles. Ground data and VHR optical scenes are the highest-resolution elements in such a process. These data are combined with wall-to-wall optical and radar data – on a Landsat or Spot level of resolution - in a process involving two-stage stratified sampling (Figure 3).

Wall-to-wall radar maps are used as alternatives for problematic areas in optical data sets, due to inevitable coverage issues caused by clouds, cloud shadows, smoke and spatially varying aerosol properties.

All levels of the multi-sensor stratified approach are used in a solid statistical analysis that in addition to forest covered areas produces reliability and accuracy estimates for these products.

As **experimental** sensors and methods, interefometric coherence is studied - besides classical SAR amplitude data - as an input feature to large area forest mapping. Potential of new SAR sensors such as the Sentinel 1 with its high image repetition frequency is studied in view of using these novel sources of data towards the end of project ReCover or in services after the project. The multi-sensor approach combining radar, hyperspectral imaging sensors and lidar data is studied for enhanced forest cover mapping. New sensors like Sentinels 1 and 2 by ESA and very-high-resolution SAR satellites TerraSAR-X and COSMO Skymed are also evaluated for the future enhanced services.

1.2.2 Forest cover change

Challenges in forest cover change

The following challenges that were listed in the previous section "Strategic reasoning of ReCover" are particularly relevant to forest cover change mapping: *solid statistical concept, increase accuracy of principal data, change, potential of radar, interactive analysis, not only REDD but sustainable forest management, standardized services, and capacity building*.

State-of-the-art in forest cover change

The objective of forest cover change mapping in the REDD context is to discriminate between areas that have – according to the applicable criteria of forest – 1) changed from forest to non-forest, 2) changed from non-forest to forest, or 3) stayed as forest or non-forest over the change mapping period.

Most of the deforestation or forest cover change work so far has been made with optical satellite imagery like Landsat (MSS, TM, and ETM+), Spot or IRS. The REDD sourcebook (GOFC-GOLD Sourcebook 2009, June 2009 edition, p. 127) states that not a single country had used (airborne) radar imagery in their reporting of land use and land use change as required by the Kyoto Protocol. Only one country (New Zealand) had used airborne lidar and even that country had used it in combination with ground data. Optical data has been used for instance by Achard et al (2002) to estimate the deforestation rate for the entire humid tropical forests.

Change detection techniques in remote sensing can be roughly grouped into feature extraction and classification, or difference or ratio of radiometric values followed by thresholding and similarity measures (Alberga 2009 on combined SAR and optical data). An unsupervised change detection method relying on k-means clustering (Häme et al., 1998) and designed for forestry applications has been put into operative use since more than five years. SAR images are also well suited for mapping changes in forest cover. Forest cover changes in the entire French Guiana were mapped between 1993 and 2003 in C-band SAR from ERS AMI and ENVISAT ASAR sensors (Häme et al. 2009). A forest area decrease of 0.5 percent resulted from the ASAR-based mapping while sample points indicated a decrease of 1.1 percent. Temporary backscatter increase after slashing of forest is known, followed by a decrease when logged areas are cleared (Almeido-Filho et al., 2009). Radar data in forest cover change mapping has also been studied by Fransson et al. (2007, 2008), Haarpaintner et al. (2009a), and Yatabe and Leckie (1995). Airborne lidar change detection has been used for deriving canopy attributes at 5 years intervals (Wulder et al. 2007). Gobakken (2005) obtained poor accuracies on two-years forest growth monitoring, but Tsuzuki et al. (2009) estimated successfully forest carbon stock within 2 years. Forest change detection for forest growth detection and harvested tree detection has been studied by Hyyppä et al. (2009).

Development beyond the state-of-the art in forest cover change in ReCover

The approach of project ReCover involves a flexible set of input data sets in forest cover change mapping. For mapping of forest change from the early years of Landsat era, an intelligent sensor-to-sensor calibration algorithm is combined with a statistical sampling approach to overcome the inevitable holes in coverage due to atmospheric phenomena or system artefacts typical to older satellite images.

VHR optical imagery are used to map forest cover change combined with wall-to-wall optical or radar datasets. Innovative and statistically sound sampling techniques are developed for the expansion of forest cover change observations outside the area covered by VHR data.

The role of atmospheric effects on image quality increases with increasing number of intermediate time points in a forest change time-series. Techniques for conditioning radar data from different satellites are developed to further harmonize radar data sets into temporally coherent image time-series, which are used in robust forest cover change mapping. Statistical techniques are used to combine forest cover change mapping between optical and radar datasets where the time points may vary widely due to limitations in available data sources.

Among **experimental** sensors and methods, innovative techniques will be developed for change mapping involving a heterogeneous set of input data from VHR optical satellite data, wall-to-wall satellite imagery, and historic aerial photography. Potential of machine learning methods for change detection from multiple sensors will be investigated.

1.2.3 Forest degradation

Challenges in forest degradation

The following challenges that were listed in the previous section “Strategic reasoning of ReCover” are particularly relevant to forest degradation mapping: *solid statistical concept, increase accuracy of principal data, degradation, potential of radar, interactive analysis, not only REDD but sustainable forest management, standardized services, and capacity building*.

State-of-the-art in forest degradation

The objective of forest degradation mapping in the REDD context is to map areas where the biomass of forest trees has decreased significantly but where the applicable criteria of forest are still fulfilled.

Forest degradation is the reduction of canopy cover or biomass in a forest resulting from fire, logging, wind felling, or other similar events. Optical satellite imagery with high spatial resolution such as Landsat, Aster and Spot data have been mostly used in forest degradation mapping (GOFC-GOLD Sourcebook 2009). VHR optical imagery like Ikonos or Quickbird data and aerial videography has also been used. Degradation is more difficult and costly to identify and monitor than deforestation (DeFries et al. 2006). According to recent studies, forest degradation become discernible when VHR sensors, aerial photography, radar, and visual interpretation of imagery are combined (Häme et al. 2009). Simultaneous use of C and L band SAR offer different penetration, which may allow to identify forest degradation or regrowth (Haarpaintner et al.

2009b). Almeida-Filho et al. (2009) used experimental L-band ALOS PALSAR data and C-band RADARSAT-2 in forest degradation mapping. Lidar can detect canopy density and gaps - Yáñez et al. (2008), Morsdorf et al. (2009), which can be used as a sign of forest degradation. Crown closure estimation from lidar can also be used as an indicator for degradation (Dees et al. 2006, Falkowski et al. 2009).

Development beyond the state-of-the art in forest degradation in ReCover

VHR data from the new generation of optical satellites is used as the primary data source in forest degradation mapping in project ReCover. In many forms of forest degradation, the need for very high resolution comes from the very localised effects on forest canopy that e.g. fire wood harvesting or selective logging causes. Intelligent sampling strategies and innovative forms of interactive interpretation are used in a cost-effective way in production of forest degradation maps that conform to the user objectives expressed in SLAs and in other contexts. Rigorous statistical techniques are used to expand the results form the areas of VHR scenes to larger mapping areas in cases where VHR mapping is not necessarily required for the whole mapping area.

As **experimental** data and methods in forest degradation mapping, radar data are studied as a form of input data to map more drastic forms of forest degradation, especially in areas where optical VHR data cannot be used. Integration of lidar data for degradation mapping and degradation map validation is studied in sites where lidar data are available.

1.2.4 Forest Biomass

Challenges in forest biomass

The following challenges that were listed in the previous section "Strategic reasoning of ReCover" are particularly relevant to forest biomass mapping: *solid statistical concept, increase accuracy of principal data, biomass, potential of radar, interactive analysis, not only REDD but sustainable forest management, from growing stock to volume of carbon, standardized services, and capacity building*.

State-of-the-art in forest biomass

Terrestrial carbon sequestration is the process through which carbon dioxide (CO_2) from the atmosphere is absorbed by trees, plants and crops through photosynthesis, and stored as carbon in biomass (tree trunks, branches, foliage and roots) and soils. The term "sink" is also used to refer to forests, croplands, and grazing lands, and their ability to sequester carbon. Forestry activities can also release CO_2 to the atmosphere. Therefore, a carbon sink occurs when carbon sequestration is greater than carbon releases over some time period. Carbon sequestration is the main motivating reason for mapping forest biomass and its change over time in the REDD and more generally climatic change context. Forest biomass mapping is important also in sustainable forest management.

Biomass estimation methods can be divided into direct and indirect methods. In direct estimation, direct relationship between spectral response and biomass is sought for using techniques like multiple regression analysis, k-NN classification, neural networks, or statistical ensemble methods. In indirect methods, remotely sensed data are used for estimation of parameters, such as leaf area index (LAI), structure (crown closure and height) or shadow fraction. Biomass expansion factors are then used to estimate derived variables like tree volume or basal area. Conversion tables can also be constructed to estimate biomass from species composition, crown density, and dominant tree height.

Visual interpretation of optical imagery as well as segmentation, classification and spectral unmixing (GOFC-GOLD 2008) can be used in forest biomass estimation. One approach generates relationships between field measured biomass (and other forest variables) and moderate spatial resolution data from Landsat (Häme et al. 1997, Sirro et al. 2002, Tomppo et al. 2002) or ASTER (Muukkonen and Heiskanen 2007) and then extrapolates over large areas using coarse imagery like NOAA/AVHRR or MODIS. Häme et al. (1997) applied Landsat-derived regression models of forest stem volume to inter-calibrated NOAA/AVHRR data. A coefficient of determination (R^2) of 0.98 was obtained when estimating the average stem volume of 20 forestry board districts (average area over million ha per district). The values of R^2 in Landsat data were lower. Muukkonen and Heiskanen (2007) applied regression models between red and near-infrared bands of ASTER sensor and forest stem volume to inter-calibrated MODIS data. When estimating average stem volume for forest centre areas (about one million ha per area, 12 areas), an RMSE of 10.1 m^3/ha (bias -3.9 m^3/ha) was obtained when averaging three consecutive 8-day composite images of MODIS data. In ASTER-based biomass estimation (Muukkonen and Heiskanen 2005) the relative RMSE was higher, 44.7 percent. In tropical areas, Steininger (2000) studied Landsat TM data in biomass mapping in Brazil and Bolivia. In Brazil, the reflectance-biomass relation saturated around 15.0 kg/m^2, or over 15 years of age. In Bolivia, no significant correlation between reflectance and biomass was found. Baccini et al. (2008) used a cloud-free MODIS mosaic in biomass mapping in Africa. An RMSE of 50.5 tons/ha was obtained in an area where biomass varied between 0 and 454 tons/ha.

Carbon sequestration can also be estimated based on the rate of photosynthesis, type and age of vegetation and meteorological data. The rate of photosynthesis depends strongly on cloud cover, which can be mapped with optical satellite imagery. Carbon sequestration can also be estimated by change detection methodologies, which are similar to some techniques used in forest cover change.

A study on earth observation future requirements provided by the British National Space Centre (Qinetiq 2003) shows that for environmental studies imaging radar and lidar – besides the currently available optical imagery - are identified as essential data. Low frequency SAR, polarimetric SAR and profiling lidar are useful for vegetation canopy characterisation and biomass estimations.

L-band JERS-1 data were used in forest biomass estimation by e.g. Fransson and Israelsson (1999) and Rauste (2005). Fransson and Israelsson (1999) obtained coefficient of determination (R^2) values of 0.57…0.60 between the exponential of stem volume and radar backscattering coefficient σ^o in three JERS scenes. They estimated the saturation point (the amount of stem volume after which an increase in stem volume cannot be observed as an increase in σ^o) at 136, 130, and 157 m^3/ha in these three scenes. Also Rauste estimated the saturation point at 150 m^3/ha. The RMSE in stem volume estimation varied from 44.79 to 61.25 m^3/ha in three summer-time JERS scenes in a study site with stem volumes of 0 … 364 m^3/ha. The most important single forest variable used in indirect methods is the tree height or canopy height. SAR interferometric techniques like repeat-pass interferometry (InSAR) and polarimetric interferometry (PolInSAR) have been studied for estimating canopy height (Balzter, 2001, Askne et al., 2005). A minimum mapping unit of 1.8ha was needed to achieve acceptable tree height estimates from SRTM data (Kellndorfer et al. 2004). A phase-based interferometric approach was used by (Baltzer et al., 2007): L-band HH for ground height and X-band VV for canopy height. RVOG (Random Volume Over Ground) model, can be used for improving height measurements with multi-baseline PolInSAR (Zhou et al. 2009). Even though tree height mapping with SAR interferometric techniques has been studied this technique is not in wide operational use. In PolInSAR, the most convincing tree height results are restricted to airborne sensors even though ALOS PALSAR data has been tested by several researchers.

Nelson (1988) calculated tree heights from airborne small footprint lidar. Tokola et al. (2009) combined airborne lidar in a two-stage stratified sampling. An RMSE of 18% was obtained for biomass and carbon estimation. Lefsky et al. (2001) explained 84% of aboveground biomass variance by regression from lidar-measured canopy structure. Popescu (2007) explained 93% of the variation in aboveground biomass using individual tree metrics. Næsset et al. (2004) explained 86% of below ground biomass and 92% of above ground biomass. Straub et al. (2009) estimated timber volume from lidar.

Tsuzuki et al. (2009) sampled an area of about 5500 km² by flight lines in 4 km intervals to derive biomass. A data fusion attempt was done by Hudak et al. (2002) with Landsat ETM+ data for predicting canopy height. Space-borne full-wave laser system ICESat has also been used to derive biomass parameters on small scales. Geoscience Laser Altimeter System (GLAS) on ICESat has higher DEM accuracy concerning the tree cover estimation of different vegetation cover types on five continents (Carabajal, 2006). Lefsky et al. (2005) and Pang et al. (2008) demonstrated large area estimation of biomass and canopy height with ICESat.

Multi-Sensor approaches have been used in biomass estimation. Lidar and optical data has been used by Dees et al. (2006), Straub et al. (2009), and Maltamo et al. (2006). Treuhaft at al., (2003 and 2005) used radar and optical data including C-band SAR interferometry and LAI (Leaf Area Index) from hyperspectral optical imagery. Klonus and Ehlers (2009) used data fusion techniques with TerraSAR-X and optical data.

Development beyond the state-of-the art in forest biomass in ReCover

An intelligent combination of radar and optical EO data are used. Based on statistically sound sampling designs and optimal use of ground-measured forest inventory data, forest biomass is derived in steps from ground up. Wall-to-wall radar and optical datasets are stratified to land-cover types whose ground definition depends on the input data type used and whose properties with regard to factors of forest biomass are homogenous. VHR optical scenes, ground-measured forest inventory data, and - where available - lidar-derived information on forest biomass are used to estimate the factors of forest biomass for the land cover types, which are then aggregated to larger spatially explicit units by means of wall-to-wall EO data. Landsat or Spot type optical data from sensors like ALOS/AVNIR and radar data from Envisat/ASAR or ALOS/PALSAR are used to obtain the wall-to-wall dataset.

As an **experimental method**, the estimation of forest biomass is split into factors of biomass. Forest height, forest closure and forest type are the driver for biomass estimations. In lowland evergreen broadleaved rainforests, which is the major forest type in large areas in the tropical rainforest zone, full waveform low-resolution information of ICESat lidar data are used for canopy decomposition to various layers typical in tropical forests. Height estimations of canopies are assessed on sample basis with lidar or satellite stereo data for established systems or from radar based on new sensor systems. An intelligent combination of sample based data and full coverage are used for better biomass calculations using new metrics and parameters. These biomass calculations are expanded from allometric equations which are locally adapted to our test areas. If no direct biomass reference is known for single tree species or forest types, the deducted equations must rely on biomass estimation based on descriptive parameters. They will be estimated referring to established methods. Subsequently carbon sequestration is directly calculated from biomass estimations using conversion factors.

Upcoming optical satellites like TopSat or Sentinel-2 as well as radar satellites like Sentinel-1 and the planned P-band SAR mission BIOMASS by ESA are studied in view of including them in the options for input EO data. Polarimetric SAR interferometry and planned new space-borne lidars like DesDynl (a NASA mission) are also evaluated.

1.3 Scientific and technological methodology and associated work plan

1.3.1 Overall strategy of the work plan

The study is divided into four major Work packages and ten lower level work packages (Figure 4, Figure 5). The high level work packages are: Service Development, Service Implementation, Service Roll-out and Expansion, and Management. Timing of the work packages can be seen in Figure 6. The work will be done in an iterative manner with two production cycles to ensure continuous improvement of the services.

WP1000 contains Service Development including interaction with the users. Requirements from the users gathered from the SLAs and through direct communication are used as input in the service development. In this module the algorithms that are needed for production and system for delivering the products to the users are developed. Also possible new techniques are reviewed and progress made in parallel projects is reviewed.

In WP2000 Service Implementation the methods that have been developed under WP1000 are used for production. Once the products are ready, they will be delivered to the user using the delivery system specified and developed under WP1000. Training will be provided for the users and they can themselves validate the products. Results from the first round of production and user feedback from validation are used as inputs for the second round of service development.

Service consolidation opportunities (WP3000) are viewed as a continuous process but especially after the first round of production has finished, possibilities for service expansion are explored. This includes evaluation of possibilities to make service level agreements with new users and outsourcing of the services. One WP is devoted to project management (WP4000). Successful execution of the project requires intensive collaboration between the WPs. Relationships between the work packages are described in Figure 4.

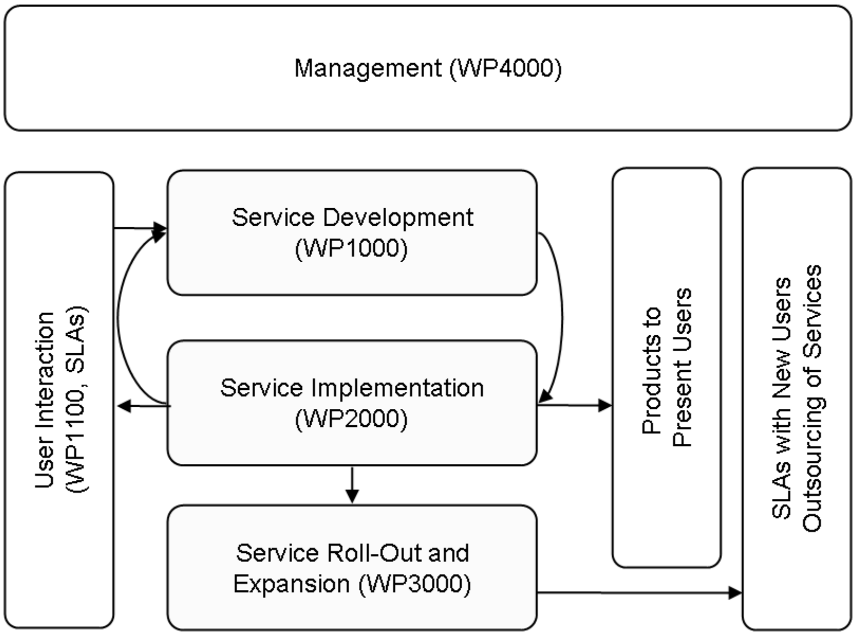


Figure 4 Schematic diagram describing the study logic and main inter-relationships between the work packages.

1.3.2 Lower level work packages

WP1000 (lead partner VTT) Service development includes four work packages that concentrate on three aspects of service development. WP1100 User interaction and International Commitments has a two-fold objective. First, activities will develop and consolidate contacts, interaction and synthesis with the different users and services of the project. This is done partly through Service Level Agreements which will be revised after the first cycle of the project. The requirements all the partners in the consortium are involved in the service provision although one partner is responsible for a service to a particular user. Work package 1100 also includes interaction between users through meetings to which they are all invited. A second and related focus is to monitor the international commitments and treaties that are essential for the Service Case development and implementation and for the international recognition of the project.

In WP1200 Algorithm Development and Statistical approach the technical capability in form of algorithms and methods are developed to fulfil the user needs. This work package includes several areas, such as data fusion, radar and lidar techniques, carbon sequestration. Statistical methodology will be developed for mapping forest cover, forest cover change, forest degradation and forest biomass using a sampling strategy with very high resolution images. The methodology will also produce rigorous statistical accuracy measures for map products and derived areal aggregate figures. Novel methods will be developed for forest biomass and carbon estimation with a combination of different types of data, radar, optical and lidar if available. Radar-based methodologies will be developed to obtain hole-free coverage of large areas. Possibilities for integrating socio-economic data with EO data will also be considered in this work package.

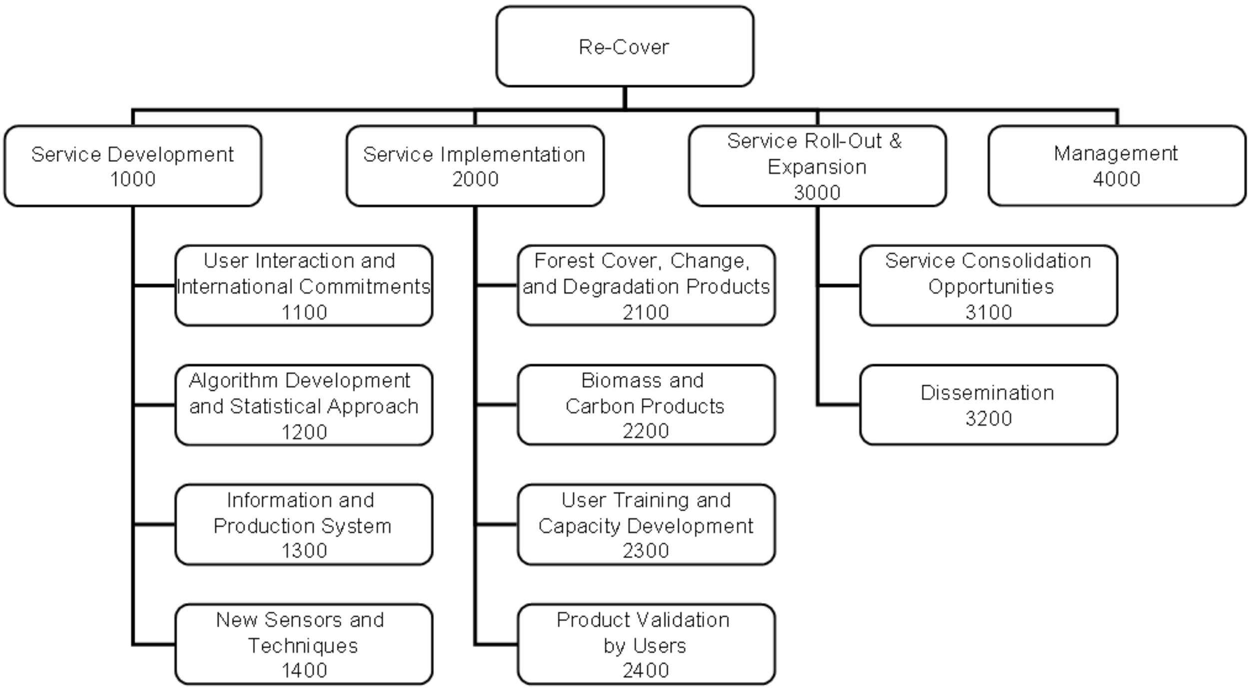


Figure 5 Work package structure of ReCover.

ReCover attracted a high number of users with challenging service needs. This positive issue also puts pressure on the delivery work packages. Thus, the output of WP1200 will be as harmonized production system as possible, in which several products can be output successively or in the same process using the same input data.

In WP1300 Information and production system development the GIS-based information system for project/user needs is developed. Central focus is on data interchange and standardization. Also the processing chains are adapted to include the methods that are developed in WP 1200 in this work package 1300.

In WP1400 New Sensors and Techniques the development of the state-of-art is monitored and updated annually. Ideas for new algorithms are developed, ways to use data from new missions such as the Sentinel program are considered. The progress of TREES-3, GSE Forest monitoring extension and similar activities are followed and an active communication with the teams of the most relevant projects is ensured. WP1400 will provide input to the next round of WP1200 and can be used as basis of discussion also in WP1100 on the second round.

WP2000 (lead partner GMV) Service Implementation includes activities that are closely linked with the production. The actual products are made in WP2100 Forest Cover, Change and Degradation Products, WP2200 Biomass and Carbon products using the production chains which have been developed under WP1000. In addition to the service provider, also other project participants participate in production of the products based on their expertise. Once the products are ready in each of the two production phases (see Figure 6), they will be presented to the users. Under WP2300 User Training and capacity development, capacity building possibilities are assessed and this also includes possibilities for project partners hosting students or researchers from the user organizations. Trainings for the users will be organized. Training ensures that the users can fully exploit the products and understand their content. The training package is also closely linked with WP2400 Product validation by the users. User validation is an essential quality control and feedback mechanism that secures a successful service implementation and further service dissemination. The validation assesses to what extent the delivered products meet the requirements of users in their specific application. The validation package provides input to WP1100 for the SLA process of the second round of the project.

WP3000 (lead partner Norut) Service Roll-Out & Expansion reaches outside the immediate project and user team. In WP3100 Service Evaluation and Expansion Opportunities the viability, effectiveness and transition to an operational forest monitoring service will be evaluated. The costs of the different products are evaluated. It is foreseen that price-quality-ratio also may affect the user requirements. The possible business opportunities of the products and services are outlined and evaluated. The expansion of the services to new users and new regions and outsourcing of services will be investigated. The users will be also contacted to ask their considerations on this issue. In WP 3200 Dissemination the results of the project are presented through several channels, for example web pages, scientific journal papers, and presentations in workshops and conferences.

WP4000 Management includes administrative, financial and supervisory issues to ensure a successful and timely completion of the project. The organizational structure of the project is defined already in the proposal and the decision-making structures will be defined in the consortium agreement. The progress of the work packages will be evaluated against the time schedule and budget. Dependencies between work packages are coordinated and information flow between partners assured. This is also done through project meetings. Management handles communication with the Commission and delivers of reports and deliverables.

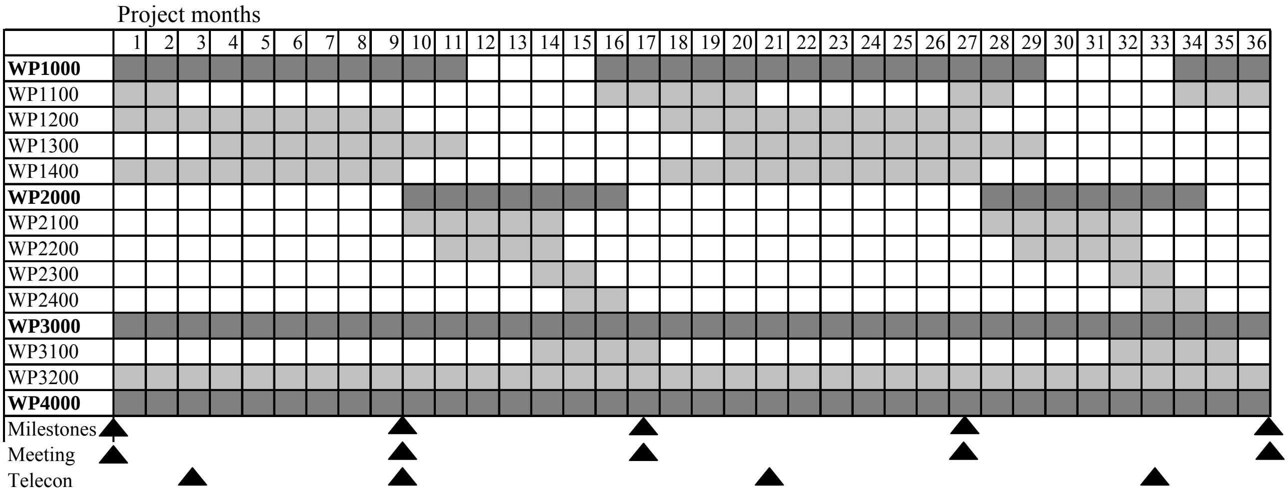


Figure 6 Gantt chart of ReCover project.

1.3.3 Risks and contingency plan

A detailed assessment of major risks and their respective remedial is presented below. Furthermore, since several methods are used in ReCover, problems in one area will not necessarily deter the developments with the other methods.

Risk: Availability of satellite data is not what expected
Risk level: *Medium*
Impact: *High*
Action: The data which are already available inside the consortium will be used. Archived data already exist. The present versions of the SLA's have some flexibility concerning the service area and they will be revised when the project begins and once during the project. The production system to be developed does not depend on the availability of data from a particular satellite. A small budget has reserved for data purchase. However, it would be a serious problem for the project if no data through Data Access Grant were obtained.

Risk: Availability of suitable ground reference data
Risk level: *Medium*
Impact: *High*
Action: For some test sites, users or partners have available ground reference data which can be used for project purposes. Partly the need for ground reference data can be compensated by using very high resolution satellite data. Efforts will be focused on the areas where the ground reference data needed for certain method is available. Some money has also been reserved for acquiring ground reference data from the users.

Risk: The products do not meet user requirements
Risk level: *Low*
Impact: *Medium*
Action: This has already been taken into account in the Service level agreement process. The target and acceptable accuracy levels will be re-considered for the next SLA, which is made around the mid-point of the project. It is also possible to relax the figures if users' needs change or if achievement of the original target accuracy is too costly, for instance.

Risk: Long delay in REDD process
Risk level: *Medium*
Impact: *Low*
Action: Possibility of this happening has been taken into account already while planning the project. This project does not benefit only REDD, but REDD+ *i.e.* sustainable forest management in general. Developing new systems takes also some time. Thus, it is sensible to start the process early.

Risk: Low budget of the overall project compared to the number of users involved
Risk level: *Medium*
Impact: *Medium*
Action: The process which is used for making the products will be standardized to enable efficient production. Taking into account the pilot nature of the project, it is important to verify the usability of the methods and products in several areas and also contact as many users as possible. The test sites are also partially overlapping so same products can be used for more than one user.

Risk: Consortium partners cannot agree because of different interests
Risk level: *Low*
Impact: *Medium*
Action: The team has worked excellently during the proposal preparation phase with good spirit of cooperation and it is foreseen that the same spirit will continue in the actual project. In addition already now all the partners have undersigned a MoU with VTT, and the consortium agreement will formally agree on the partner responsibilities.

Risk: A key person with a specific expertise leaves the project
Risk level: *Medium*
Impact: *Medium*
Action: Similar skills are available in consortium and the partners represent organizations with larger teams. It is possible to replace one expert with another in urgent occasions.

Risk: Withdrawal of partner or inability to fulfil agreed obligations.
Risk level: *Low*
Impact: *Medium*
Action: In many services there is more than one potential service provider. Reassign the work and funding to appropriate alternative partner. The Consortium Agreement will include rules regarding Defaulting partners.

Table 1.3 a: Work package list

Work package No	Work package title	Type of activity	Lead participant No	Lead participant short name	Person months	Start month	End month
1000	**Service development**		**1**	**VTT**			
1100	User interaction and international commitments	RTD	8	WU	14	T0	T0+36
1200	Algorithm development and statistical approach	RTD	1	VTT	75	T0	T0+27
1300	Information and production system development	RTD	6	GMV	31	T0+4	T0+27
1400	New sensors and techniques	RTD	2	ALU-FR	14	T0	T0+27
2000	**Service implementation**		**6**	**GMV**			
2100	Forest cover, change and degradation products	DEM	1	VTT	64	T0+10	T0+31
2200	Biomass and carbon products	DEM	2	ALU-FR	33,5	T0+10	T0+31
2300	User training and capacity development	OTHER	7	Norut	11	T0+13	T0+32
2400	Product validation by users	RTD	8	WU	11	T0+14	T0+33
3000	**Service roll-out & expansion**		**7**	**Norut**			
3100	Service consolidation opportunities	RTD	7	Norut	25	T0+14	T0+35
3200	Dissemination	OTHER	1	VTT	16	T0	T0+36
4000	**Management**	MGT	1	**VTT**	10	T0	T0+36
		TOTAL			304,5		

Table 1.3 b: Deliverables List

Del. no.	Deliverable name	WP	Nature	Dissemination level	Delivery date
1100.1	User interaction workshop	1100	O	RE	T0+17 T0+27
1100.2	User interaction report	1100	R	RE	T0+18 T0+28
1100.3	Consolidated Service Level Agreements	1100	O	RE	T0+18
1200.1	Method compendium on algorithms and statistical approach	1200	R	PU	T0+8 T0+26
1200.2	Critical design review report	1200	R	RE	T0+9 T0+27
1200.3	Socio-economic integration report	1200	R	PU	T0+25
1300.1	WEB GIS platform	1300	P	PU	T0+9, T0+29
1300.2	GIS platform user guide and report on the methods used	1300	R	PU	T0+9, T0+29
1400.1	Report on new sensors and techniques	1400	R	PU	T0+9, T0+27
2100.1A 2100.1B	Forest cover products as defined in SLAs – one per production phase	2100	D	RE	T0+14 T0+32
2100.2A 2100.2B	Forest cover change products as defined in SLAs - one per production phase	2100	D	RE	T0+14 T0+32
2100.3A 2100.3B	Forest degradation products as defined in SLAs – one per production phase	2100	D	RE	T0+14 T0+32
2100.4& 2200.4	Contribution to joint Production report together with WP2200	2100 2200	R	PU	T0+14 T0+32
2200.1A 2200.1B	Biomass distribution maps (Mg/ha) - one per production phase	2200	D	RE	T0+14 T0+32
2200.2A 2200.2B	Carbon distribution maps - one per production phase	2200	D	RE	T0+14 T0+32
2300.1	Assessment report on the users needs in capacity development	2300	R	RE	T0+15
2300.2	Report from user training and workshops	2300	R	RE	T0+15, T0+33
2400.1	Update for Web-platform of the project on the user validation outcomes and report	2400	R	PU	T0+16, T0+34
2400.2	User validation report summarizing the process, data and outcomes from the user validation exercise	2400	R	RE	T0+16, T0+34
3100.1	Service assessment report from users' feedback	3100	R	RE	T0+17, T0+35
3100.2	Assessment report on future data and products requirements	3100	R	PU	T0+17, T0+35
3100.3	Assessment report on cost/benefit and market analysis	3100	R	RE	T0+35
3200.1	Web-site for the project	3200	O	PU	T0+1
3200.2	Dissemination Plan	3200	R	RE	T0+9, T0+27
3200.3	Dissemination material including material to promote the service to new users through internet and brochures	3200	R	PU	T0+17, T0+35

Del. no.	Deliverable name	WP	Nature	Dissemina tion level	Delivery date
4000.1	Management reports	4000	R	RE	As defined in the contract
4000.2	Progress reports	4000	R	Re	T0+17, T0+27
4000.3	Final report	4000	R	PU	T0+36

Table 1.3 c List of milestones

Milestone number	Milestone name	Work package(s) involved	Expected date	Means of verification
M1	Kickoff		T0	minutes
M2	Design review 1	WP1000	T0+9 (either face-to-face meeting or telecom based on needs)	Methods compendium Critical design review report (minutes)
M3	Progress Meeting 1	WP2000, WP3000	T0+17	Products ready Results of user validation
M4	Progress Meeting 2, Design review 2	WP1000	T0+27	Updated Methods compendium Critical design review report (minutes)
M5	Final Meeting	WP1000, WP2000, WP3000, WP4000	T0+36	Final report

Additional project internal teleconferences (more teleconferences and informal gatherings will be arranged *ad hoc*)
T0+3, T0+21 discussions on user requirements and how they could be realized (possible algorithms)
T0+33, discussion on validation results and user training, final reporting

Gantt chart has been added below for the convenience of the reader.

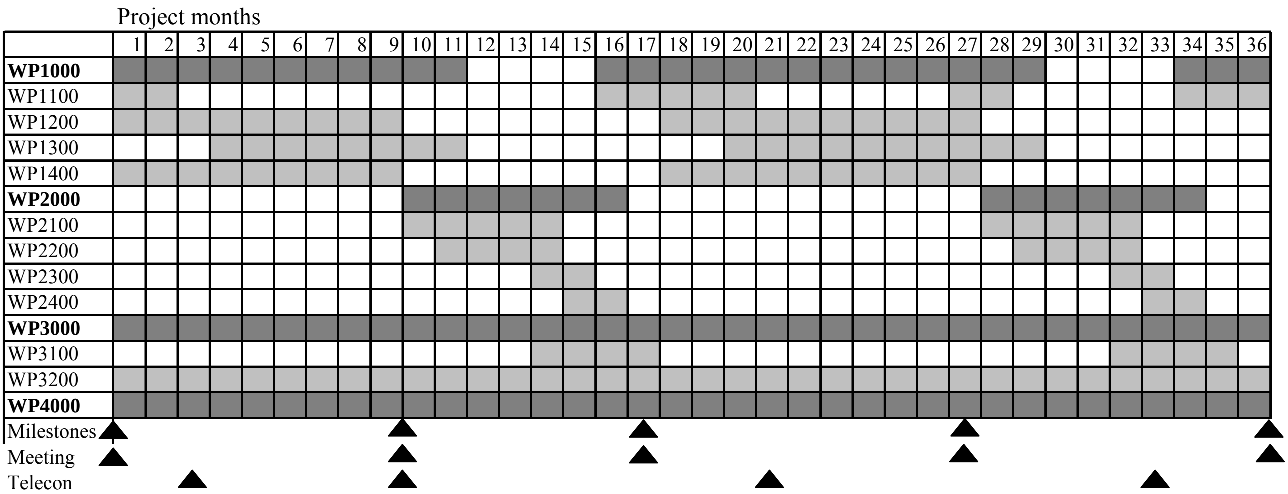


Table 1.3 d: Work package description

Table 1. WP structure and the challenges identified in section 1.1.1.

Challenge / Impacts	WP1100	WP1200	WP1300	WP1400	WP2100	WP2200	WP2300	WP2400	WP3100
CHALLENGES									
Solid statistical concept									
Increase accuracy of principal data (VHR)									
Forest cover									
Biomass estimation, carbon balance, growing stock volume									
Degradation (several definitions)									
Change, baseline, trend: sophisticated, easy to use									
Potential of radar for forest applications									
Interactive analysis									
Sustainable forest management, REDD+									
From growing stock volume to carbon									
Standardized services: formats, accuracy evaluation procedures									
Capacity building for space-borne earth observation in the developing countries									
Preparing monitoring continuity with news sensors and techniques									

Legend
Dark gray: included in WP description
Light gray: inherent although not specifically mentioned

Work package number	1100	**Start date or starting event:**			T0			
Work package title	**User interaction and international commitments**							
Activity Type	RTD							
Participant number	1	4	5	7	**8**	9		
Participant short name	VTT	COL POS	ECO SUR	Norut	**WU**	INPE		
Person-months per participant:	3	1	1	2	6	1		

Objectives

- develop and consolidate contacts, interaction and synthesis with the different users and services of the projects
- monitor the international activities in the context of the UN climate convention and REDD, related policy impacts and monitoring and reporting requirements
- to build synergies with Earth Observation activities working on the international level including a dedicated GEO task, FAO's FRA 2010 remote sensing survey and JRC's TREES 3 and GOFC-GOLD activities

Inputs

- Service Level Agreements available from the beginning of the project (Annex of this proposal)
- Consolidated list of users and participants (from WP1100)

Work description

The work package is twofold and driven by the fact the project has a global scope with users from different continents. The Service Level Agreements are the foundation of the user interaction and will be further developed during the project and finalized in a workshop to coordinate and cooperate for the overall project objectives, the Earth Observation concepts for forest monitoring and REDD, and in the framework of this GMES contribution. Limited study areas in each country will be defined more clearly for the first production phase, and whole study areas will be refined in consolidated SLAs and used in the second production phase. A second and related focus is on the international commitments that are essential for the Service Case development and implementation and for the international recognition of the project. The project will closely monitor the international activities in the context of the UN climate convention and REDD, related policy impacts and monitoring and reporting requirements, and to build synergies with Earth Observation activities working on the international level including a dedicated GEO task (in particular Carbon Tracking), FAO's FRA 2010 remote sensing survey and JRC's TREES 3 (both use the same sample locations and data), and activities of GOFC-GOLD (REDD Sourcebook development and implementation). The user interaction mechanism will be continued over the course of the project and feed into implementation (i.e. user validation WP 2400) and service consolidation opportunities and dissemination work packages (i.e. WP 3100, WP3200).

The work will be implemented through interactional cooperation and interaction mechanism that will build upon the GOFC-GOLD panel (Partner WU) and bring together the users and service providers of the project:

- Implement a user interaction workshop to inform about GMES, the project, REDD and monitoring requirements and the related earth observation service cases (in conjunction with project progress meetings),
- Assist users with background materials prepared by the project,
- Summarize outcomes of the international political negotiations for a post Kyoto climate agreement and REDD and assess implications for the service cases
- Provide input to the standardized data exchange platform for the project,
- Participate in key international activities such as UNFCCC events, GEO task meetings, GOFC-GOLD workshops and FAO/JRC events to advocate the activities of this task, seek synergies and contributions,
- Synthesis experiences from the service through presentations to the international community

Outputs

- o Consolidated Service Level Agreements (to WP1200)
- o Input to WP1300 Product on chain adaption and information system development

- Input to project WP3200 dissemination and website

Deliverables
1100.1 User interaction workshop, report and background materials (T0+17, T0+27 in conjunction with project progress meetings)
1100.2 User interaction report, including study area definition, summarizing the process, agreements and outcomes from the user interaction : synthesis on international initiatives and REDD political negotiations, including assessment of impacts for SLAs (T0+18, T0+28)
1100.3 Consolidated Service Level Agreements (T0+18)

Work package number	1200	**Start date or starting event:**			T0			
Work package title	Algorithm Development and Statistical approach							
Activity Type	RTD							
Participant number	**1**	2	3	4	5	6	7	8	9
Participant short name	**VTT**	ALU -FR	Arbo naut	COL POS	ECO SUR	GMV	Norut	WU	INPE
Person-months per participant:	14	15	4	7	5	8	9	11	2

Objectives

- To develop algorithms and methods – based on the current status of the art, and R&D work beyond that state – that meet the expectations of users of the ReCover services
- To develop the statistical approach used in forest cover, change, and degradation products as well as forest biomass and carbon products and in the validation of these products
- To develop a pilot process line that effectively can output products with harmonized approach sequentially using the same input data or even several variables in the same process

Description of work

Input

- Scientific literature
- User requirements from WP 1100
- Consolidated SLAs from WP 1100
- In-house methods and software
- Satellite and *in-situ* data for method development

Main work

Task 1210 – Statistical methods
Development of a statistical methodology for mapping forest cover, forest cover change, forest degradation and biomass using a two stage stratified sampling strategy with very high resolution images as the base line method in the development. The methodology will also produce statistically sound accuracy measures for map products and derived areal aggregate figures.

Task 1220 – Forest cover
Development of novel methods for forest cover mapping trough crown closure and forest type classification. The method combines a sample of VHR data and wall to wall data. A segmented and classified VHR image can be used as training data to wall to wall data to bridge the gap between in-situ data and wall to wall data resolutions. The forest cover map will be used as one input in biomass estimation.

Task 1230 – biomass and carbon
Development of novel methods for forest biomass and carbon estimation making optimal use of optical very high resolution data, wall-to-wall radar data, wall-to-wall optical data with associated cloud/atmospheric quality data, supported by airborne lidar data where available, and multi-sensor approaches. Forest parameters that are required in biomass estimation include tree height, crown closure and tree or stand type. These data are the basis to estimate stand mean diameter, stand age and finally wood volume. Alternatively the volume is directly estimated. The wood volume estimates are transformed to biomass by applying expansion factors (BEM). These expansion factors depend mainly on the tree or forest type and tree or forest age.

The existing expansion factors will be reviewed for different forest types in different growing areas. The structure of tropical or subtropical forest types is very different compared to boreal and temperate forests where quite good results are achieved for derived biomass estimation based on a variety of remote sensing based parameters. Especially lowland evergreen broadleaved rainforests, which is the major forest type of our test area in Brazil, is of the most complex structure. Therefore new parameters need to be extracted which are tested to improve the biomass estimation. Subsequently carbon sequestration is directly calculated from biomass estimations using conversion factors.

Task 1240 – forest degradation
Development of robust forest degradation methods that use a combination of wall to wall data and very high resolution optical data as well as combination of visual and numerical interpretation. The methods are linked with forest cover and biomass estimation. These methods should be applicable in a cost effective way in all study sites where forest degradation is a user requirement.

Task 1250 – forest change analysis
Development of robust, widely applicable forest change mapping methodologies producing also statistically sound confidence intervals for the estimated changed area.

Task 1260 – socio-economic integration
Integrating socio-economical data (such as population pressure, life expectation, …) with EO that might lead to identify relationships between deforestation and quality of life. The scope of the socioeconomic integration analysis in ReCover aims at providing a broad synthesis of three main elements affecting sustainable forest management: economics, society and ecology. Economic and societal statistical geo-indicators will be analysed along with the ReCover EO spatial products taken from National and International statistical agencies.

Task 1270 – SAR techniques
Development of radar-based methodologies for applications where state-of-the-art approaches use optical data: As most tropical countries endure persistent cloud cover through most of the year, space-borne optical sensors suffer from difficulties to obtain hole-free coverage of large areas to map. Approaches and mapping methodologies are developed for combined optical-radar mapping. It is foreseen that full radar coverage is an essential element of the developed methodologies in order to guarantee timely and cost efficient mapping in areas where incomplete optical coverage is likely. Radar data is also supposed to improve mapping reliability of illegal cuttings and fire scars, where optical imagery may be smoke infested in the driest, least cloudy seasons.

Outputs
- Algorithms and processing lines that can be used in production of forest cover, change, and degradation products
- Algorithms and processing lines that can be used in production of forest biomass and carbon products

Deliverables
1200.1 Method compendium on algorithms and statistical approach (T0+8, T0+26)
1200.2 Critical design review report (T0+9, T0+27)
1200.3 Socio-economic integration report (T0+25)

Work package number	1300	Start date or starting event:			T0+4			
Work package title	Information and Production System Development							
Activity Type	RTD							
Participant number	1	2	3	4	5	**6**	7	8	9
Participant short name	VTT	ALU-FR	Arbonaut	COLPOS	ECOSUR	**GMV**	Norut	WU	INPE
Person-months per participant:	4	3	1	2	2	12	3	3	1

Objectives

- to analyze product formats and definitions so to provide the guidelines for standardized data production and provision
- integrate data into a GIS-based information system
- adapt the algorithms developed in WP1200 to the processing chains
- to propose a flexible portal solution that can be configured to meet the requirements of specific thematic domains or different user categories, making it easier to integrate COTS client components

Description of work

Input

- WP1100 user interaction report
- WP1200 method compendium
- INSPIRE directive and its implementations
- WP2100/2200 Service products
- Existing in-house solutions

Work description

In ReCover, services will be offered through a modular portal, based on open service oriented architecture.

Task 1310 - ReCover portal

The ReCover Portal will be based on mature and validated results from other projects, enhanced by the migration to a fully portlet-based solution supporting the JSR-168 or WSRP standards.

Each product developed within ReCover should be considered as a layer to be integrated in a GIS common environment where data analysis can be performed. The web site shall include Web-based GIS functionality, through the usage of Web Map Service (WMS) standard and/or Google Earth for an online visualisation of the products. Basic spatial analysis functionalities such as map overlay and transparency, map algebra, vector integration and data extraction, EO and non-EO data integration may be implemented. Products will be available to the users through a WMS compliant with the Open Geospatial Consortium (OCG) standards. Several OGC protocols can be used to import geographic information from the service provider hosting capabilities or extracted from external locations available from internet to the GIS platform. Relying on open standards makes later on capacity building more accessible and cost-effective for users.

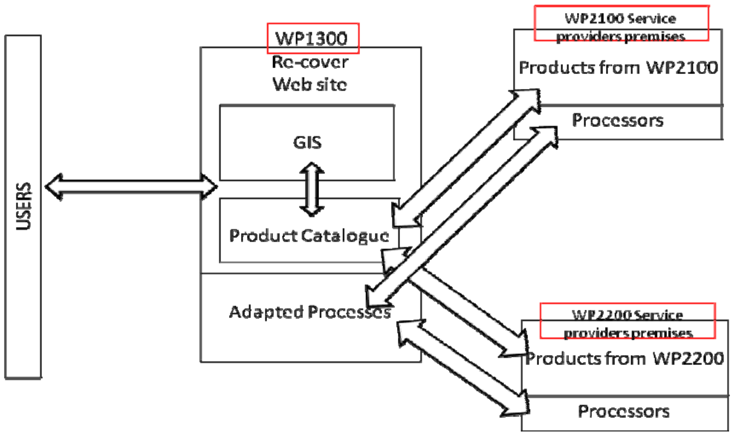
Task 1320 – Protocols

The following standard protocols may be used: WMS, WFS, CSW, WPS. To adapt the processing chains to the common portal, it is proposed to use this latter, which defines how GIS calculations are made available to the Web. WPS can describe any calculation (i.e. process) including all of its inputs and outputs, and trigger its execution as a Web Service.

Task 1330 – Metadata

Within ReCover, not only data interchange will be standardized, but also each product will have to be compliant to the predefined standard: data will be metadated according to the INSPIRE directive, issued by the European Commission. Since most of present and past GMES projects have already contributed to the expansion of the scope of the directive a preliminary study on how to implement it within ReCover will be performed.

The following figure describes the overall architecture.



Task 1340 – Adaptation of the processing chains
Actual adaptation of the processing chains of each partner will be done under this work package. The algorithms selected and developed in WP1200 will be implemented to the processing chains of the respective partners. Each partner will take care of processing of their own products.

Outputs

– Input to other WPs
  - Analysis of the INSPIRE directive and its implementations to identify applicability to ReCover products
  - State of the art document of the standards relevant for ReCover forest applications
  - Definition of the interoperability concepts (including metadata definition, data harmonization, data and service sharing) to produce standard products

Deliverables
1300.1 WEB GIS platform that integrates satellite EO data (either satellite or airborne), in-situ data and the WP2000 products in a common system and provide advance processing capability (T0+9, T0+29)
1300.2 GIS platform user guide, including report on the methods used (T0+9, T0+29)

Work package number	WP1400	Start date or starting event:			T0			
Work package title	**New sensors and techniques**							
Activity Type	RTD							
Participant number	1	**2**	8					
Participant short name	VTT	**ALU -FR**	WU					
Person-months per participant:	4	7	3					

Objectives

- evaluate the potential of most recent and upcoming sensors for monitoring forest cover, deforestation, forest degradation, biomass and carbon stocks
- evaluate the potential new algorithms and techniques

Description of work

Inputs

- scientific literature
- in-house results from other projects
- Results from WP1100, WP1200 and WP1300
- The results from the Geoland services (if available)
- Data from new satellites
- *In-situ* data

Work description

Under new sensors recent and near-future systems are considered: TerraSAR-X, TanDEM, ALOS and the COSMO-SkyMed constellation, Pleiades-HR 1 and HR 2, LiDAR data from ICESat satellite, the Sentinel missions, German EnMAP satellite, and ICESat 2. Predictions concerning the application and integration of data from upcoming systems into new algorithms can partly be simulated. The new technologies will be tested alone and in combination with the WP 1200 output. It is also evaluated whether the methods that have been developed in GMES Geoland core services ‘Natural Carbon Fluxes’ and ‘Global Land Cover & Forest Change’ observatories or the methods developed in GEO Forest Monitoring and described in the REDD source book can be enhanced.

Task 1410 – new satellite systems

Development of methods for extraction of the information on deforestation, forest degradation, biomass and carbon stocks from different satellite systems. For the method development we will refer to the combined design of area wide and sample based inventory method of WP 1200.

Regarding the optical sensors the higher spectral or spatial resolution of future systems is of main interest for the sample based approach. The Pleiades system delivers a spatial resolution that comes close to aerial images. This might be of advantage for forest degradation monitoring due to its large scale pattern characteristics. Approaches to generate DSM based on satellite stereo data and derive stand heights will be tested. Hyper-spectral data are candidates to improve forest or tree type classification as well as LAI estimation which supports biomass estimation.

The new technical features of the imaging radar satellite systems demand further research and exploration of their information content. For the studies based on intensity values especially the combination of different polarisations are of interest while for the interferometric approaches the coherence information and phase-based height estimations are in focus of the research. The valuation of tomographic approaches is included in form of a subcontract provided by the Technical University in Karlsruhe.

Lidar needs more investigations to exploit the complementary geometrical information for forest areas.

Airborne as well as space-borne data will be used in the sample based approach. For ICESat data with its relative large footprint it will be observed how terrain relief will influence the results and if there are techniques to compensate these effects. New methods will be developed which analyses the full waveform to get a better target differentiation for large footprint sizes. Finally also the height information which can be extracted from LiDar data in tropical regions will be analysed.

Task 1420 – multi-sensor techniques
Development of a multi-sensoral approach which integrates the information from different sensor types in order to improve the information content on deforestation, forest degradation, biomass and carbon stocks. The information from different new and old data sources will be comparatively analyzed for their applicability to monitor the requested forest parameters.

Task 1430 – Frequent mapping of forest changes
Frequent change detection to monitor forest fires and illegal cutting using principally SAR data. This demonstration activity will be carried out only in limited areas where such changes occur frequently enough for method development.

Outputs
The results of this WP may be directly used for forest cover, change detection and deforestation products (WP 2100) and biomass and carbon estimations (WP 2200) of the second round of production. The main focus is to map possible activities beyond ReCover project.

Deliverables
1400.1 Report on the potential and integration of new techniques and data from new sensors into the services (T0+9, T0+27)

Work package number	2100	**Start date or starting event:**			T0+10				
Work package title	**Forest Cover, Change, and Degradation Products**								
Activity Type	DEM								
Participant number	**1**	2	3	4	5	6	7	8	9
Participant short name	**VTT**	ALU-FR	Arbo naut	COL POS	ECO SUR	GMV	Norut	WU	INPE
Person-months per participant:	12	10	3	5	4	8	8	12	2

Objectives

- To derive forest cover products as defined in SLAs
- To derive forest cover change products as defined in SLAs
- To derive forest degradation products as defined in SLAs

Description of work (possibly broken down into tasks), and role of participants

WP 2100 makes use of algorithms and methods developed in WP1200 and possibly in WP1400. For product delivery it uses the portal developed in WP1300.

Input

- Consolidated SLAs from WP 1100
- Methods and processing chains from WP 1300
- Methods compendium from WP 1200
- New methods and processing software from WP 1400 if applicable
- Satellite and *in-situ* data

Work Description

WP 2100 produces SLA-specified services on:

- forest cover,
- forest cover change, and
- forest degradation.

The services are delivered to the user as a coordinated effort by the consortium. One named service provider in the ReCover consortium is responsible for the service as a whole for the service of each user. Other partners (in addition to the responsible service provider) in the consortium will participate in the production. A named partner is responsible for the high quality and timely delivery of the products that are produced as a cooperative activity. The work share between partners has been preliminarily been agreed on. In addition one partner can share tools and in-house software for all the services (as shown in Annex 7). The work share will be specifically defined in the consortium agreement.

The product generation in WP 2100 includes:

- acquisition of EO data,
- acquisition of *in-situ* data,
- pre-processing of EO data including (e.g.) atmospheric corrections to optical data rectification (or ortho-rectification if needed) of optical and radar data, radiometric corrections due to topographic effects,
- pre-processing of *in-situ* data including (e.g.) format conversions, aggregation of stand-wise values in cases forest inventory data includes tree-species-wise data, conversions to raster images when needed,
- image analysis to generate the products,

- post-processing to adapt to the product distribution portal developed in WP 1300, and
- computation of accuracy and reliability estimates for the products.

All production is separated into two phases, as illustrated in the Gantt chart of ReCover project :

- in the first round of delivery, all products are delivered in a limited study area to be agreed with the users. Mosaic products are delivered over the whole study area defined in SLAs already in the first round.
- in the second phase, products are delivered over the whole study area as defined in SLAs.

The two-phase delivery approach allows getting feedback from users before second phase.

All production work should conform to Good Practice Guidance for Land Use, Land-use Change and Forestry as well as to other IPCC related definitions. The data needed and output data are fed into a database, contributing to sustainable forest management.

Task 2110 – Service delivery to Mexico : **VTT**, Arbonaut, Colpos, Ecosur

Task 2120 – Service delivery to Brazil : **Norut**, INPE, ALU-FR

Task 2130 – Service delivery to Guyana : **WU,** ALU-FR, GMV

Task 2140 – Service delivery to Fiji : **WU,** GMV, VTT

Task 2150 – Service delivery to DRC : **Norut,** ALU-FR

Outputs
- Guidelines and products to user training (WP2300) and user validation (WP2400)

Deliverables
In first production phase – limited study site, part of SLAs :
2100.1A Forest cover products (T0+12 ready, T0+14 delivery at the same time with products from WP2200)
2100.2A Forest cover change products (T0+12 ready, T0+14 delivery at the same time with products from WP2200)
2100.3A Forest degradation products (T0+12 ready, T0+14 delivery at the same time with products from WP2200)
In second production phase – full study site:
2100.1B Forest cover products as defined in SLAs (T0+30 ready, T0+32 delivery at the same time with products from WP2200)
2100.2B Forest cover change products as defined in SLAs (T0+30 ready, T0+32 delivery at the same time with products from WP2200)
2100.3B Forest degradation products as defined in SLAs (T0+30 ready, T0+32 delivery at the same time with products from WP2200)

2100.4 Contribution to joint Production report together with WP2200 (T0+14, T0+32)

Work package number	2200	**Start date or starting event:**				T0+10		
Work package title	Biomass and carbon products							
Activity Type	DEM							
Participant number	1	**2**	3	4	5	6	7	8	9
Participant short name	VTT	**ALU -FR**	Arbo naut	COL POS	ECO SUR	GMV	Norut	WU	INPE
Person-months per participant:	5	7,5	2	3	2	5	3	4	2

Objectives

- To derive biomass products as defined in SLAs
- To derive carbon sequestration maps as defined in SLAs

Description of work (possibly broken down into tasks), and role of participants

Input

- Consolidated SLAs from WP 1100
- Methods and processing chains from WP 1300
- Methods compendium from WP 1200
- New methods and processing software from WP 1400 if applicable
- Products from WP 2100
- Satellite and *in-situ* data

Work Description

WP 2200 produces SLA-specified services on:

- forest biomass,
- carbon sequestration

The services are delivered to the user as a coordinated effort by the consortium. One named service provider in the ReCover consortium is responsible for the service as a whole for the service of each user. Other partners (in addition to the responsible service provider) in the consortium will participate in the production. A named partner is responsible for the high quality and timely delivery of the products that are produced as a cooperative activity. The work share between partners has been preliminarily been agreed on. In addition one partner can share tools and in-house software for all the services (as shown in Annex 7). The work share will be specifically defined in the consortium agreement.

The product generation in WP 2200 includes:

- acquisition of EO data (as much as needed in addition to what are available from WP2100),
- acquisition of *in-situ* data (as much as needed in addition to what are available from WP2100),
- pre-processing of EO data including (e.g.) atmospheric corrections to optical data rectification (or ortho-rectification if needed) of optical and radar data, radiometric corrections due to topographic effects (as much as needed in addition to what are available from WP2100),
- image analysis to generate the products,
- post-processing to adapt to the product distribution portal developed in WP 1300, and
- Biomass estimation through direct or indirect method (through other forest metrics plus expansion factors)
- Computation of carbon sequestration using conversion factors
- Computation of accuracy and reliability estimates for the products.

Output will be several biomass map products (Mg/ha) using the method compendium developed for different input data or input data combinations by WP 1200, WP 1300 und WP 1400. For all biomass maps finally the conversion into carbon sequestration (t/ha) will be calculated.

As in WP2100, all production is separated into two phases :

- in the first round of delivery, all products are delivered in a limited study area to be agreed with the users. Mosaic products are delivered over the whole study area defined in SLAs already in the first round.
- in the second phase, products are delivered over the whole study area as defined in SLAs.

The two-phase delivery approach allows to get feedback from users before second phase. The data needed and output data are fed into a database, contributing to sustainable forest management.

Task 2210 – Service delivery to Mexico : **VTT**, Arbonaut, Colpos, Ecosur

Task 2220 – Service delivery to Brazil : **Norut**, INPE, ALU-FR

Task 2230 – Service delivery to Guyana : **WU,** ALU-FR, GMV

Task 2240 – Service delivery to Fiji : **WU,** GMV, VTT

Task 2250 – Service delivery to DRC : **Norut,** ALU-FR

Outputs
- Guidelines and products to user training (WP2300) and user validation (WP2400)

Deliverables (brief description and month of delivery)
In first production phase – limited study site, part of SLAs :
2200.1A Biomass distribution (Mg/ha) (T0+14)
2200.2A Carbon distribution maps (t/ha) (T0+14)
In second production phase – full study site :
2200.1B Biomass distribution (Mg/ha) (T0+32)
2200.2B Carbon distribution maps (t/ha) (T0+32)

2200.4 Contribution to joint Production report together with WP2100 (T0+14, T0+32)

Work package number	2300	**Start date or starting event:**			T0+13			
Work package title	User training and capacity development							
Activity Type	OTHER							
Participant number	1	2	3	4	5	6	**7**	8	9
Participant short name	VTT	ALU-FR	Arbonaut	COLPOS	ECOSUR	GMV	**Norut**	WU	INPE
Person-months per participant:	1	1	1	1	1	1	3	1	1

Objectives

- Provide the user with necessary information and, if needed, the necessary know-how and tools to handle, use evaluate and validate the delivered products and services.

Description of work

Input

- products delivered in WP 2100 (Forest cover, change and degradation products) and WP 2200 (biomass and carbon products) as well as necessary meta data, additional information and tools.
- accuracy estimations of the products
- Input from WP1100

Work Description

The end-users capabilities are diverse. Some end-users, for example Brazil and Mexico, have already high standard monitoring capacities as well as reporting methodologies in place, while other countries (f.e. DRC, Fidji) need the necessary capacity building to be able to fully evaluate and use the products to report their GHG emission. The user need for capacity building will partly be assessed through the user interaction work package (WP1100).

User training and capacity building workshops are organized with the delivery of the products, during the two product delivery phases. Skilled users are encouraged to share their experience and engage actively in capacity building workshops. In cases that there is already a south-south cooperation in place, this project aims to complement and support such cooperation.

The capacity building will be implemented among other things by receiving staff members of user organizations to the premises of service providers for training.

The user training will include training on the techniques, future technological possibilities and service as well as on the specific products provided during the project. The idea is to contribute to a general capacity building in the area of satellite remote sensing and Carbon/REDD reporting. The aim is that users should not only be able to use the data but can also contribute actively in the definition, implementation and in-house processing of the developed and future services. The material for the workshops will be prepared by the consortium partners and divided in regard to their specific specialization inside the fields of remote sensing and international guidelines of carbon accounting and reporting. This work package includes also possible exchange of students/ researchers from user countries to partner organizations.

The work done under this work package includes :

- Assessing the users original capabilities and necessary needs
- User needs: Deriving user specific recommendations and capacity development needs
- Encourage new and support existing south-south cooperation :
- Prepare user training for all users to evaluate and use the delivered products, and to participate actively in the service definition.
- Organize the user training workshops

The user training workshops will be held at convenient locations that reflects the totality of the users' geographic distribution, having users from the Americas, Africa and Oceania.

Outputs

- Course material for the workshops (T0+14, T0+32),
- User training and capacity development workshops (T0+15, T0+33),
- This work package will enhance the user’s capability to participate to WP2400.

Deliverables

2300.1 Assessment report on the users needs in capacity development (T0+15)
2300.2 Report/minutes from the meetings/workshops including the course material (T0+15, T0+33)

Work package number	**2400**	**Start date or starting event:**			T0+14			
Work package title	**Product validation by users**							
Activity Type	RTD							
Participant number	1	4	5	7	**8**	9			
Participant short name	VTT	COL POS	ECO SUR	Norut	**WU**	INPE			
Person-months per participant:	1	2	1	1	**4**	2			

Objectives
Assess to what extent the products delivered meet the requirements of users for their application

Input (items that are relevant to this WP)
- From other WPs
  - Service Level Agreements (from WP1100)
  - Consolidated list of users and participants (from WP1100)
  - Service products (incl. internal validation information) from the different cases (WP 2100 and 2200)
  - User training workshop and materials (WP 2300)
- Input in situ data
  - Ground reference data from users for different service cases
- Input satellite data
  - Satellite observations and map products as reference from users for different service cases

Work description

The validation of the output products delivered by the services will be performed by the users and is an essential quality control and feedback mechanism for success of the service implementation and further service dissemination. This work package will implement the user validation and product assessment including three major components:
1. Common and agreed product validation procedures for different service cases. Depending on the service outputs to be assessed (i.e. forest type map, area change estimate, biomass estimation), different types of accuracy assessment approaches are needed and will be specified.
2. Implementation of the validation by the users and consolidation of the results for the individual service cases. This task involves the active technical engagement of the user for evaluating the service products and outcomes.
3. Synthesize the outcomes of the user validation among the different service cases. The result of the user interaction is the essential input to assessing the success and usefulness of the services provided and impacts the service dissemination strategy.

The work will be implemented by the different users with input and guidance from the project and the service providers. All products will be delivered to the individual users; including information on internal product accuracy assessments and among with some technical guidance on how the user would able to perform the validation given a set of available reference information. The set of common and agreed product validation procedures for different service cases will be consolidated during the user training workshop. The users will perform the validation and report the assessment on the set of delivered products, their accuracies and how well the products meet their needs. The service providers prepare a response to the user validation. A synthesis assessment among all user validation outcomes will performed by the consortium to update the service cases and as input to the further service dissemination. The process will be fully transparent and the outcomes will be documented in a series of reports.

Outputs
- Report on user validation outcomes (to WP 3100)
- User feedback workshop (users are invited to progress meetings)

- Internal summary on service provider response and user validation synthesis (to WP 3100)
- Internal summary on service provider response on the user validation synthesis for the General public

Deliverables
2400.1 Update for Web-platform of the project on the user validation outcomes and report (T0+16, T0+34)
2400.2 User validation report summarizing the process, data and outcomes from the user validation exercise (T0+16, T0+34)

Work package number	3100	**Start date or starting event:**				T0+14		
Work package title	Service Consolidation Opportunities							
Activity Type	RTD							
Participant number	1	3	4	5	6	**7**	8	9	
Participant short name	VTT	Arbo naut	COL POS	ECO SUR	GMV	**Norut**	WU	INPE	
Person-months per participant:	5	2	1	1	5	6	4	1	

Objectives
Assess the viability, effectiveness and the transition to an operational forest monitoring service for tropical forest countries, promote the service to a larger user community and evaluate the cost/benefit of the service, to develop a business plan.

Description of work
The aim of this project is to develop beyond state-of-the-art service capabilities to support REDD activities, meaning that it is focusing on R&D activities. The overall aim and natural continuation however will be to establish an operational GMES service. To reach this goal, several tasks should be performed already during the development phase, which are:

Task 3110 - Service assessment by the established users
The GMES Service Element concept asks for a close involvement of the end-users in the establishment of a GSE service. The user input is not only important for the product requirement, but also for the specification of the service set-up and if possible in the definition of future observing platforms, i.e. satellite systems, service products, etc.

Task 3120 - Assess the future product requirements, data availabilities and possible improvements for a continuing service
The user feedback is therefore also an important input to define future products requirements that themselves are dependent on data availabilities in order to improve the service. Upcoming space programs, like the Sentinel Series, and the success of future potential missions, like the BIOMASS satellite as a future Earth Explorer Mission will be highly dependent on user needs. Requirements of REDD+ (Sustainable forest management) will also be assessed.

Task 3130 - Assessing the global interest for such a service through promoting the service and connecting to new users and regions
An important task to reach a viable service is to have a sufficient amount of users. Promoting the developed service to other users and demonstrate the possibility to extend the service to other regions is therefore necessary to assess the global interest. Applications of the methods and products to a wider scope than REDD will be highlighted for sustainable forest management.

Task 3140 - Assess the possibility of operational roll-out of the service to commercial or in-house service providers
To establish a future GMES service it is necessary to find a reliable continuous service provider. The current service providers are research institutes, which is feasible for a development project but it is not in their mission to be operational service providers once the service is established. In this work package we will assess potential commercial providers within and outside ReCover consortium or help to implement in-house operation of the users themselves. Some of the current users already have operational set-up capabilities, knowledge and infrastructure to take over the services once it is fully developed and act as service provider in the future. Other potential service providers need to be identified for other regions. For a self-sustainable service roll-out, a cost/benefit analysis as well as a market analysis need to be done. The costs of the different products are evaluated and their price-quality-ratio also may affect the user requirements. The possible business opportunities of the products and services are outlined and evaluated.
This work package provides input to WP1100 for the SLA process.

Deliverables
3100.1 Service assessment report from users' feedback (T0+17, T0+35)
3100.2 Assessment report on future data and products requirements (T0+17, T0+35),
3100.3 Assessment report on cost/benefit and market analysis (T0+35).

Work package number	3200	**Start date or starting event:**				T0			
Work package title	Dissemination								
Activity Type	OTHER								
Participant number	**1**	2	3	6	7	8			
Participant short name	**VTT**	ALU -FR	Arbo naut	GMV	Norut	WU			
Person-months per participant:	5	2	2	3	0	4			

Objectives
The objectives of the ReCover dissemination are to:

- Increase awareness of the project, its objectives and achievements
- Inform target groups about results from the project
- Involve and gain feedback from participants of the UNFCC REDD process and other users of the developed services
- Coordinate with other projects and networks
- Cooperate with standardisation bodies

Description of work (possibly broken down into tasks), and role of participants

A project website will be established within the first project month to provide the forum for dissemination of the results, papers, and information about the project. All public deliverables will be available at this site. The website will be available in English.

General dissemination material (flyers, posters and articles etc.) will be prepared and delivered at different events, seminars, press media etc. The project will be disseminated through presentations and promotional material at major events like the technical side events of UNFCCC conferences of parties. The results will be presented at international conferences to provide a wide forum for dissemination, and to offer a common forum for the entire international scientific community and REDD stakeholders. Scientific papers written during the project will inform the scientific community in peer-reviewed journals.

Deliverables
3300.1 Web-site for the project (updated throughout the project) (T0+1)
3200.2 Dissemination Plan (T0+9, T0+27)
3200.3 Dissemination material including material to promote the service to new users through internet and brochures (T0+17, T0+35)

Work package number	4000	**Start date or starting event:**				T0		
Work package title	Project Management							
Activity Type	MGT							
Participant number	**1**							
Participant short name	**VTT**							
Person-months per participant:	10							

Objectives

This work package is devoted to the coordination and overall management of the project to ensure the smooth operation of the project and that the project objectives will be met within given budget and timeline. This work package also includes:

- Arrangement of contractual matters and correspondence between Commission and the consortium,
- Management of all financial matters between Commission and the consortium partners,
- Management of the report production for deliverables and other reports and submission to Commission

Description of work (possibly broken down into tasks), and role of participants

Inputs:

Contract
Tender documents
Kick-off meeting and agreements

Description of work:

The project management will supervise all technical activities of the project and control the overall work progress against the planned time schedule and the running costs against the budget planning. It will also co-ordinate the dependencies between the work packages and takes care of a smooth realisation of the work.

The project management will arrange all contractual matters between the consortium and Commission and it will correspond to Commission and transmit any official correspondence of Commission to the partners during the project lifetime.

The project management will prepare the cost statements for Commission after collection and control of the information from partners. In the other direction, it will distribute the payments of Commission to the partners according to their respective shares.

The project management will prepare the deliverables for Commission including the interim and final reports, compiling background material submitted by the partners.

The project management will undertake general dissemination activities, which comprise reporting, communication and publication activities.

VTT as the coordinator has the overall project responsibility.

Deliverables

Reports as defined in the contract :
4000.1 Management reports (According to the contract)
4000.2 Progress reports (T0+17, T0+27)
4000.3 Final report (T0+36)

Table 1.3 e Summary of staff effort

Table 1.3 e Summary of staff effort. WP managers **indicated** as bold.

Participant no./short name	WP 1100	WP 1200	WP 1300	WP 1400	WP 2100	WP 2200	WP 2300	WP 2400	WP 3100	WP 3200	WP 4000	Total person months
1 VTT	3	**14**	4	4	**12**	5	1	1	5	**5**	**10**	64
2 ALU-FR	0	15	3	**7**	10	**7,5**	1	0	0	2	0	45,5
3 Arbonaut	0	4	1	0	3	2	1	0	2	2	0	15
4 COLPOS	1	7	2	0	5	3	1	2	1	0	0	22
5 ECOSUR	1	5	2	0	4	2	1	1	1	0	0	17
6 GMV	0	8	**12**	0	8	5	1	0	5	3	0	42
7 Norut	2	9	3	0	8	3	**3**	1	**6**	0	0	35
8 WU	**6**	11	3	3	12	4	1	**4**	4	4	0	52
9 INPE	1	2	1	0	2	2	1	2	1	0	0	12
Total	14	75	31	14	64	33,5	11	11	25	16	10	304,5

2 Implementation

2.1 Management structure and procedures

2.1.1 Organisational structure

The project will be managed in 4 levels (Figure 7), ie. by:

1. **Project management committee**
2. **Project coordinator**
3. **Work package management** by nominated WP leader with help of higher level WP leaders
4. **Service providers** managing the user interaction

Project management committee (MC) will represent highest level of decision making within the project and will decide on the management issues, including technical, exploitation, financial, planning and control matters. The MC is responsible for the accomplishment of the project plans and will ensure that the deliverables are supplied and milestones reached according to the timetable. The MC will also evaluate and control the scientific and technical progress of the project and adopt appropriate actions to correct deviations from the time schedules. The MC will meet in the progress meetings and through teleconference between the progress meetings. The MC will comprise of one member from each partner and project coordinator, who will act as a chairperson of the MC. The decision-making structures will be defined in the **consortium agreement (CA)**.

VTT as the **project coordinator** is responsible for the administrative, financial, technical/scientific and organisational management of the project as a whole and is the point of contact with the European Commission. A specific project management work package has is included in the project to allow implementation of the management. The project manager will be Prof. Dr. Tuomas Häme who has a long experience in managing European projects and wide international network. He is responsible for the general success and scientific quality of the project. Dr. Anne Lönnqvist will be the deputy project manager. Her specific responsibilities are everyday communication with the consortium and schedule and delivery control. Both Dr. Häme and Dr. Lönnqvist participate also in the technical work.

VTT has a professional EU team which supports project managers of EU funded projects in all financial and administrative aspects at the proposal stage and during the whole lifespan of the project. The team consists of 16 full time financial professionals. The team has a lot of experience in guiding partners in VTT coordinated projects. VTT's Legal Affairs will act as strong support for the management of the Project. VTT Legal Affairs consists of several lawyers experienced especially in contractual issues and IPR, including EU framework projects. Both Legal Affairs and EU team members have experience from FP2 framework onwards.

The project has been organised in **four higher level work packages** and ten lower level work packages. For each work package the project partner with relevant interests and expertise has been allocated as the work package leader. The partner which has been assigned to be the leader of these higher level work packages will be coordinating the activities between the lower level work packages. The work package leaders of the lower level work packages coordinate the activities between the partners inside the work package.

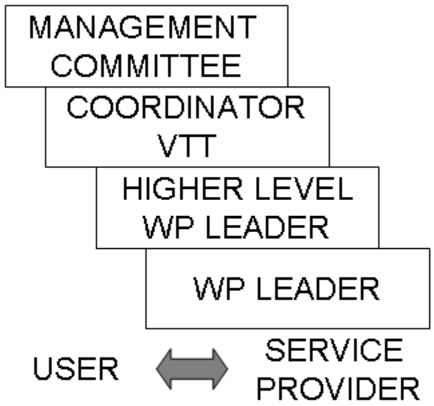


Figure 7. Management structure of ReCover.

Service providers named in the Service Level Agreements (SLA) will take care of communication with their respective users and passes information on their requirements related to the products to the consortium. The service providers ensure that the products are delivered to the user. WP leaders of the production work packages ensure that the products are available and meet quality specification described in the SLAs.

2.1.2 Decision making procedures and consortium agreement

The management committee MC will be the highest decision making body of the project. The operational procedures of the MC shall be laid down in the Consortium Agreement. The following principles shall be followed:

- Each partner shall have the right to nominate a representative to participate in the MC meetings
- Each partner shall have the amount of votes corresponding to its project share
- The responsibilities and authority of the MC shall be clearly listed, covering issues of changes in the technical implementation of the project, evolution of the consortium and process relating to the coordination of IPR issues and distribution on EU funding
- The decisions shall be taken by the majority of 2/3 of the parties represented in the meeting.
- The possibility of a partner to veto decision shall be specified in detail and shall be limited to cases of severe impact on a partners legitimate interests
- The proper action needed with regard to non-performing of under-performing partners shall be addressed

In addition to the rules relating to MC, also the role and mandate of the coordinator shall be identified in more detail in the Consortium Agreement. The detailed decision making procedures aim to minimize the risk of problems occurring in the implementation of the project and shall provide mechanisms for resolution of emerging conflicts.

2.1.3 Meetings, reporting and quality assurance

Meetings will have an important role in the communication strategy and knowledge transfer within the consortium. The key meeting instrument is the combined management committee and project progress meeting, which will be organized once a year face to face and through teleconference between the meetings. Additional meetings will be arranged according to needs. The agenda of each project meeting will be defined as a coordinated effort with all WP and Task leaders, all project participants and the EC. Project meeting minutes will report on the project status, relevant points of discussion and will document all action items identified during the meeting.

Effective reporting will be demanded from all partners. The reports are included in the list of deliverables. Deliverables and milestones are monitored to evaluate the achievements of the project. The scientific outcome, i.e. publications and conference presentations and possibilities for applying patents are also followed.

Progress report contains work completed during the period, work planned for the next period and work behind schedule. It will report on measures to resolve major issues, e.g. of work behind the schedule, and will include a report on all management activities (including financial issues) as required by the EC contract.

Quality Assurance (QA) will be applied to all internal and external activities and deliverables. Quality assurance is the joint responsibility of all partners throughout the project. The goal of QA is to ensure detection of errors as early in the project life cycle as possible, and to carry out activities to ensure these quality objectives are met. Any relevant issues, especially non-conformance, will be documented, corrective actions planned, applied and documented in quarterly progress reports.

The project manager has the authority for implementing and verifying compliance with all quality evaluation policies and procedures related to the project. The following is a non-exhaustive list of QA tasks that will be performed:

- Develop QA project instructions, procedures, checklists, action item lists, and report standards (e.g. deliverable report formats).
- Monitor project development to ensure that initial project plan goals are met within time and budget. Furthermore, each of the partners will report every six months to the project manager on the progress of their work package and the amount of person months spent, as well as on problems encountered and schedule changes, if any.
- Review deliverables for consistency, clarity, technical content, and adherence to report standards. In particular, an internal review process will be defined and applied to each deliverable prior to its delivery to the EC.
- Conduct audits of processes prior to each development phase of the project (e.g. is the work distribution within tasks clearly defined among the ‘subject working groups’? Is personnel available for upcoming tasks?) and assure the existence of specifications for each phase.

2.2 Individual participants

VTT Technical Research Centre of Finland (VTT, Espoo, Finland) P1

Qualification and capacity

VTT is a non-profit-making research organisation which has 2700 employees. VTT's turnover in 2008 was 245 M€ of which close to three quarters came from contract work and joint research programs. Basic governmental funding was 30 %. VTT has considerable experience in contract research projects and is able to tackle in effective way complex R&D tasks. VTT serves annually over 6000 domestic and foreign customers. In the field of remote sensing we develop advanced image interpretation methods to retrieve information from digital satellite images. Our special fields of expertise are remote sensing of the natural environment, particularly forestry applications and sea ice monitoring. Technologically the main interest presently is in the analysis of multi-source data, very high resolution data, and imaging radar data.

Selected reference projects

- geoland2 – Integrated GMES project on Land Cover and Vegetation (2008-2011) http://www.gmes-geoland.info
- GSE Forest Monitoring Stage 1 (2003-2005), GSE Forest Monitoring Stage 2 (2005- 2008): GMES – projects with focus on forestry applications. (ESA, www.gmes-forest.info)
- Laos_SilvaSat Feasibility study on the forest monitoring concept using very high resolution satellite data (2009)
- NewForest – Renewal of forest resource mapping (2009-2010)

Key scientific / technical personnel

Dr. Tuomas Häme, born 1955, holds a Research Professorship in Earth Observation at VTT being responsible for the remote sensing research at VTT. He has wide experience in project and team management including economic management. He is also well experienced in remote sensing and user needs due to a long career in a multidisciplinary organization for contract research since 1979 and longer visits abroad (North Carolina State University 1989 and Joint Research Centre, Space Applications Institute,12/1994 - 6/1996.
Dr. Anne Lönnqvist, born 1977, has a strong background in radar and satellite antenna measurements and simulations. She has been working in the field of remote sensing since 2007. Application areas of the resent projects have been land cover mapping and forest stem volume estimation with both optical and radar data.
Phil.lic Jorma Kilpi, born 1966, has background in Mathematics. He got the Master of Science and Phil.lic. Degrees from the University of Helsinki, Departement of Mathematics in 1994 and 1997. Since 1998 he has been working as Research Scientist at VTT in the field of Teletraffic Statistics. Recently he has also worked in the field of remote sensing, studying issues related to statistical sampling designs**.**
Dr. Yrjö Rauste, born 1956, has a strong background in analysis and processing of optical and SAR data. He was the project manager in the NewSAR project concentrating on processing of data from the satellites of the polarimetric generation. Yrjö Rauste played a key role in the compilation of country-wide radar mosaics for French Guiana in ESA-funded project GSE Forest monitoring (led by GAF).
Mr. Matthieu Molinier (M. Sc. In Image Processing, PhD student in Machine learning). He has 5 years of professional experience in the fields of change detection in optical medium and very high resolution, polarimetric analyses in SAR imaging, machine learning for remote sensing, methods development and rapid prototyping for various remote sensing applications including forestry.

Selected relevant publications

1) Rauste, Y., T. Häme, H. Ahola, N. Stach, and Henry, J.B., 2007. Detection of forest changes over French Guiana using ERS-1 and ASAR imagery. ESA SP-636, Proc. Envisat Symposium, Switzerland, 23-27 April.
2) Häme, T., Salli, A., Andersson, K. & Lohi, A. 1997. A new methodology for the estimation of biomass of conifer-dominated boreal forest using NOAA AVHRR data. International Journal of Remote Sensing 18(15):3211-3243.
3) Häme, T., Heiler, I. & San-Miguel Ayanz, J. 1998. An unsupervised change detection and recognition system for forestry. International Journal of Remote Sensing 19(6):1079-1099.
4) Häme, T., Rauste, Y., Sirro, L., Stach, N., 2009. Forest cover mapping in French Guiana since 1992 using satellite radar imagery, Proceedings of ISRSE 33 Symposium. Stresa, Italia, 4 - 9 May 2009.
5) Molinier, M., Laaksonen, J., Häme, T., Detecting man-made structures and changes in satellite imagery with a content-based information retrieval system built on self-organizing maps, IEEE Transactions on Geoscience and Remote Sensing., Vol. 45 (2007) No: 4 (April), 861 – 874.

Albert-Ludwigs-Universität Freiburg ALU-FR FeLis (www.felis.uni-freiburg.de) P2

Qualification and capacity

FELIS - Department of Remote Sensing and Landscape Information Systems is part of the Faculty of Forestry and Environmental Sciences at Albert-Ludwigs-Universität Freiburg. FELIS carries out both basic and application-oriented research in inventories, monitoring systems and impact assessments in the fields of forestry and landscape. The department has around 20 scientists working in the field. A large number of EU and national funded projects have been successfully carried out by FELIS, who have also coordinated several of them, including the ReGeo project, which has been awarded as one of the best projects by State of Baden-Württemberg and the European Commission in 2005. In addition, FeLis members have received the Best Paper Award from the International Journal of Remote Sensing in 2006 and the ISPRS Youth Award for Best Scientific Paper in 2008. Currently, the major projects are in LIDAR inventory applications (NATSCAN (www.natscan.de) and MATCHWOOD (www.matchwood.uni-freiburg.de)), in high resolution optical satellites (GEO and GMES initiatives) and multi-sensoral applications like for the ESA project DUE INNOVATORS with focus on forestry.

Selected reference projects

- ReGeo - Multimedia Geoinformation for e-communities in rural areas (2002-2005 FP6 IST-2001-32336, www.regeo.org)
- GSE Forest Monitoring Stage 1 (2003-2005), GSE Forest Monitoring Stage 2 (2005- 2008): GMES – projects with focus on forestry applications. (ESA, www.gmes-forest.info)
- Geobene. Global Earth Observation – Benefit Estimation: Now, Next and Emerging. (FP6, Proposal no.: 037063, www.iiasa.ac.at/Research/FOR/geobene.html**)**
- WoodWisdom Net - WW Iris New Technologies to Optimise the Wood Information Basis for Forest Industries - Developing an Integrated Resource Information System. www.UMB.no/ina/ww-iris
- ESA Project DUE INNOVATORS InsectCombat, ESRIN/AO/1-5781/08/I-EC 2009

Key scientific / technical personnel

Barbara Koch Prof. Dr. (F) Head of FELIS. Expert in forest engineering, land use planning and spatial information systems. She has more than 20 years of professional experience in the field with remote sensing and worked with all data types like optical, radar and lidar data in the field of forestry. Barbara Koch will be responsible for the overall science content of FeLis.

Holger Weinacker Dr. in Geodesy (M). Senior expert in remote sensing and laser application in forestry. Scientist and project manager of national, EU and ESA funded projects. Holger Weinacker will be responsible for remote sensing algorithm and application development for Lidar and Microwave data. .

Johannes Heinzel MSc. Geography (M), (will hold a PhD in Remote Sensing when he starts collaboration within this project) . Expert in Lidar and optical data processing and works with new classification algorithms like Support Vector Machines. He is experienced in the development of advanced pattern recognition algorithms for forestry applications.

Selected relevant publications

BREIDENBACH J., KOCH B., KAENDLER G., KLEUSBERG A. (2007): Quantifying the influence of slope, crown shape and stem density on the estimation of three height at plot level using Lidar and InSAR data. International Journal of Remote Sensing, Vol. 29, Issue 5 March 2008, pp. 1511 – 1536.

IVITS E., LAMB A., LANGAR F., HEMPHILL S. & KOCH B. (2008): Orthogonal transformation of segmented SPOTS images: seasonal and geographical dependence of the Tasselled Cap parameters. In: PE&RS Vol. 74 No. 11 Nov. 2008 pp.

DEES M. & KOCH B. (2008): Forestry applications. Advances in Photogrammetry, Remote Sensing and Spatial Information Sciences. 2008 ISPRS Congress Book, Li, Chen &Baltsavias (eds),

STRAUB C., DEES M., WEINACKER H. & KOCH B. (2009): Using Airborne Laser Scanner Data and CIR Orthophotos to Estimate the Stem Volume of Forest Stands. In: PFG 03/2009, S 277-287.

STRAUB C., WEINACKER H. & KOCH B. (2009): A Comparison of Different Methods for Forest Resource Estimation Using Information from Airborne Laserscanning and CIR Orthophotos. In: European Journal of Forest Research D-09-00060. Submitted.

Arbonaut P3

Arbonaut Ltd. is a forest resource systems company based in Joensuu, Finland. Arbonaut was founded in 1994 and has since helped forest management organisations worldwide to know better what kind of forest resources they possess, and how to use and manage them better. Arbonaut's longterm customers include several of the world's largest forest companies and forest management organisations. Arbonaut stays at the forefront of forest management technology by intensive collaboration in forest research with the leading universities in the field. Arbonaut's **ArboLiDAR forest inventory method** combines airborne laser scanning and satellite and aerial images with field measurements to produce a highly accurate estimate of forest resources on both plantations and in natural forests. It has been successfully used on over half a million hectares in Europe, in North and South America and in South East Asia. Arbonaut also integrates forest information into **Forest Information Systems (FMI)** that allow planning for harvesting and thinning operations, for forest road and drainage construction, for managing national parks and for managing relations with forest owners that have outsourced the management of their forests. Arbonaut uses multiple platforms in its Geographical Information Systems, ranging from ESRI and MicroStation based systems into Open Source GIS based systems, with thousands of users.

The ReCover project coordination will be undertaken by Jarno Hämäläinen, forester (M.Sc.), who acts as manager for REDD and sustainable forestry services at Arbonaut. He possesses very wide and international expertise regarding to the forest resource information system development and management. He has gained long-term overseas field experience i.e. in Tanzania and Mozambique. Dr. Tuomo Kauranne, founder and president of Arbonaut Ltd, will participate as a depute coordinator from Arbonaut's side in the ReCover project framework. Besides there will be other development and operational staff members involved but they are pointed out later according to the emerging resource needs.

Colegio de Postgraduados (ColPos), COLPOS P4

The Postgraduates College is a national institution that has contributed, since its foundation in 1959, to the development of the country through the establishment of academic programmes in nearly all the disciplines of agronomic and forestry sciences and related areas and through carrying out research and consulting in Mexico. The academic staff is composed by more than 600 professors. The institution has a large tradition working with international organizations like EC, FAO, WMO, World Bank, etc. The research activities are directed to solving basic and applied problems, from biotechnology to rural development. The academic programmes in the College of Postgraduates cover almost all activities related to agronomic and forestry sciences, and related fields. One of the most relevant academic works is in forestry, soil sciences, and remote sensing (www.colpos.mx)

Associated Research Professor **Dr. Fernando Paz-Pellat (Risk and natural resources management assisted by remote sensing group)** has been Research Professor in the University of Sonora, Mexico, 1982-1991, and Director of the Research Centre in Eng. in the same university, 1983-1987. His research activities has been directed to the development of insurance products based on remote sensing technology (AVHRR and MODIS), irrigation assistance with remote sensing (SPOT, LANDSAT, ASTER), yield forecasting using remote sensing, Radar technology, etc. He is the chairman of the Science Steering Committee of the Mexican Carbon Program, and leader of the MRV component implementation of the Mexican REDD strategy. He is member of the national group in charge of the GHG inventories for AFOLU sector

Dr. Jorge Etchevers-Barra (Edafology Department) is a Professor of Soils Science at the COLPOS, Mexico, and a Permanent Visiting Professor of the Universidad of Concepción, Chile. In later years his main field of research has been soil carbon, carbon sequestration and recuperation of degraded soils. He is member of the National Advisory Council on Climate Change. He is a regular member of the Mexican Academy of Science and the National Academy of Agricultural Science of Mexico. Dr Etchevers co-coordinated the chapter on LULUCF sector of the national greenhouse inventory for Mexico and has conducted several studies on carbon mitigation in the agricultural sector of Mexico. He is member of the National Advisory Council on Climate Change and the Science Steering Committee of the Mexican Carbon Program.

Dr. Rene Valdez-Lazalde (Forestry Deparment) is a Professor of Geomatics and Forest Management at the COLPOS Forestry Program, Mexico. Dr. Valdez received a Bachelor of Science degree in Forest Management and Economics from Universidad Autonoma Chapingo, Mexico (1992), a M.Sc. degree with a major in Forest Resources at Oklahoma State University (1997), and a Ph.D. with a major in geomatics at Colorado State University's Forest Sciences Department (2001). Dr. Valdez served as the Mexican representative at the World Forest Institute from March, 1994 to March, 1995. His main interests and research are on the application of geomatics based tools and multi-criteria spatial decision support models to the assessment of forestry related land suitability, land use cover and change dynamics, the estimation of forest biophysical variables through remote sensing derived data, and radar and lidar technology.

Selected relevant publications

BALBONTÍN, C. ET AL. 2009. SOIL CARBON SEQUESTRATION IN DIFFERENT ECOREGIONS OF MEXICO. IN: SOIL CARBON SEQUESTRATION AND THE GREENHOUSE EFFECT. 2ND ED. SSSA SPEC. PUBL. 57. R. LAL AND R.F. FOLLETT (ED.) SSSA, MADISON, WI. (BOOK CHAPTER)

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PRADO, B. ET.AL. 2009. IMAGE PROCESSING-BASED STUDY OF SOIL POROSITY AND ITS EFFECT ON WATER MOVEMENT THROUGH ANDOSOL INTACT COLUMNS. AGRICULTURE WATER MANAGEMENT.

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ROMERO, E, ET AL., 2009, DESIGN OF A SPECTRAL VEGETATION INDEX UNDER THE JOINT PERSPECTIVE OF EXPONENTIAL AND LINEAR GROWTH PATTERNS. AGROCIENCIA 43:291-307.

El Colegio de de la Frontera Sur ECOSUR P5

The College of the Southern Border (ECOSUR) is a federal research institute that has contributed, since its foundation in 1974, to the development of the southern states of Mexico with research in the areas of Biodiversity conservation, alternative production systems and social and health conditions of rural populations. The total academic staff comprises about 120 researchers distributed in the four states bordering Guatemala and Belice, Chiapas (2 separate units), Tabasco (1 unit), Campeche (1 unit), and Quintana Roo (1 unit). Ecosur has a Masters and Doctorate programme, in which each year between 60-90 students enroll, thus contributing to the development of leaders in the fields of agricultural, forestry, conservation and social sciences. The institution has a large tradition working with international and national organizations like EC, World Bank, etc. The research activities are directed to solving basic and applied problems, mainly directed towards rural development.

Key scientific / technical personnel

Dr. Bernardus H.J. de Jong (Tropical Forest Ecology) has a full Research appointment in Ecosur since 1992 and director of the Villahermosa unit since 2007 (temporal). His research activities has been directed towards assessing the potential of Greenhouse Gas mitigation in the forestry sector, including measurements of carbon stocks in various land use classes, analysis of land use change based on remote sensing (Landsat, Spot) and carbon modeling in forest ecosystems He has a major interest in incorporating remotely sensed land use data in GIS to develop land-use change risk maps. He is member of the Science Steering Committee of the Mexican Carbon Program, and one of the leaders of the preparation of the Mexican REDD strategy. He is coordinator of the national group in charge of the GHG inventories for AFOLU sector, and member of the National Consultative Board on Climate Change. He has published more than 30 papers in peer-reviewed journals and book chapters and directed various doctoral and master students.

Dr. Miguel-Angel Castillo Santiago (Remote Sensing, Forestry). Is responsible of the Laboratory of Geographic Information of Ecosur. His research is directed towards identification of forest structure characteristics with Remote Sensing (SPOT, IKONOS, Landsat). Has experience in modeling land-use change through driver analysis. He has various publications related to land-use change dynamics and Remote Sensing.

Selected relevant publications

– M. A. Castillo Santiago, M. Ricker and B. H. de Jong. 2010. Estimation of tropical forest structure from SPOT-5 satellite images. *International Journal of Remote Sensing (in press).*

– Ordoñez, J.A.B., B.H.J. de Jong, et. al. 2008. Carbon content in vegetation, litter, and soil under 10 different land-use and land-cover classes in the Central Highlands of Michoacan, Mexico. *Forest Ecology and Management* 255: 2074-2084.

– M. Skutsch, et.al 2007. Clearing the way for reducing emissions from tropical deforestation. *Environmental Science and Policy* 10: 322-334.

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– S. Brown, et.al. 2007. Baselines for land-use change in the tropics: application to avoided deforestation projects. *Mitigation and Adaptation Strategies for Global Change* 12: 1001-1026.

– De Jong, B.H.J. et. al. 2007. Application of the “Climafor” baseline to determine leakage: the case of Scolel Té. *Mitigation and Adaptation Strategies for Global Change* 12: 1153-1168.

– Castillo-Santiago, MA; et al. 2007. Carbon emissions from land-use change: a regional analysis of causal factors in Chiapas, México. *Mitigation and Adaptation Strategies for Global Change* 12: 1213-1235.

– De Jong B.H.J., A. Hellier, M.A.Castillo-Santiago, and R.Tipper. 2005. Application of the “Climafor” approach to estimate baseline carbon emissions of a forest conservation project in the Selva Lacandona, Chiapas, Mexico. *Mitigation and Adaptation Strategies for Global Change*. 10: 265-278.

– De Jong, B.H.J., et.al. 2004. Economics of Agroforestry Carbon Sequestration. A Case Study from Southern Mexico. In: J. Alavalapati and E. Mercer (eds.). Valuing Agroforestry Systems: Methods and Applications. Kluwer Academic Publishers, Advances in Agroforestry 2. Pp 123-138.

GMV P6

Qualification and capacity

GMV is a privately owned technological business group with international presence. Founded in 1984. GMV offers solutions, services and products in diverse sectors. GMV's objective is to support technologically advanced solutions by providing integrated systems, specialized products, and services that cover the entire service life, from consulting services and engineering, to the development of hardware and software, integration of turnkey systems and operations support. Within GMV, the SEOPS Unit (Science and Earth Observing Processing Systems) will undertake the responsibilities planned in this proposal. SEOPS has involved its technological achievements in the EU 6FP & 7FP through GMES applications for forest monitoring, natural risk monitoring, atmosphere, security, marine and coastal environments, humanitarian relief and forest fire management. SEOPS is currently involved in projects demanding GIS environmental modeling and spatial database management.

Selected reference projects

- DRUID (ESA), in response to the "New Opportunities In support of the Forest Based Market" call. Provision of pre-commercial forest services: clear cut areas and above-ground biomass modelling
- PYROS (ESA): toolbox development within the Fuegosat Consolidation (Step-2: IR Element Definition within GMES). Improvement of the forest fire monitoring and data dissemination through GIS
- FUELMAP (JRC): development of a European fuel map based on a novel classification scheme suited to the EU environments
- FIREHARM (JRC): determination of forest fire causes and harmonization of methods for reporting
- GSE Forest Monitoring (ESA): provision of forest type classification maps in the Mediterranean area, through Envisat-MERIS, AWiFS, Landsat ETM+ and SPOT-5 imagery
- LINHE: integration of LIDAR, digital camera, NIR and hyper-spectral sensors. Spanish National Research Programme. Ministry of Industry project

Key scientific / technical personnel

María Julia Yagüe Ballester, Dr. in Geography (F), has a long experience in earth observation domain. Julia has a wide experience in the field of geo-information products production and analysis and has worked in several GMES projects such as ESA RESPOND and FOREST MONITORING; currently, she is involved in GMES LIMES; GMOSAIC, SAFER projects .

Donata Pedrazzani, MSc Computer Science (F), has acquired experience in earth observation based applications. The areas of interest and expertise focus on HR and MR optical image processing and remote sensing series in application fields such as forestry, wildland urban interfaces, and security.

Selected relevant publications

- D. Pedrazzani et al, "Testing Meris Fr Capabilities And Limits To Map Forest Classes", Oral presentation, Proceedings of 2nd MERIS/(A)ATSR User Workshop 22nd- 26th Sept. 2008, ESA/ESRIN Frascati (Rome) Italy
- Antolín, R. et al."Linhe Project: Development Of New Protocols For The Integration Of Digital Cameras And Lidar, Nir And Hyperspectral Sensors", Proceedings of SilviLaser 2008, 8th int. conference on LiDAR applications in forest assessment and inventory, Sept. 17-19, 2008 – Edinburgh, UK
- Yagüe, J., García, M. P. A mined sand dune revegetation sequence in Myall Lakes, NSW, Australia. Proceedings of the Third International Workshop on the Analysis of Multitemporal Remote Sensing Images. 16-18 May 2005, Mississippi, USA, pp. 59-63.
- Yagüe, J., García, M. P. (2005). Evaluating soil degradation in the Jarama-Tajuña and Tajo River Basins (Autonomous Region of Madrid, Spain) Using Remote Sensing Techniques. Sustainable Use and Management of Soils. Arid and Semiarid Regions. A. Faz Cano, R. Ortiz y A. R. Mermut.(Ed): Advances in GeoEcology Nº 36, CATENA, Verlag. ISBN 3-923381-49-2. US ISBN 1-59326-244-2
- Yagüe Ballester, J. (2003). Multitemporal remote sensing of land surface temperatures over the Iberian Mediterranean fringe. Proceedings of the NATO – CCMS and Science Committee Workshop on "Desertification in the Mediterranean Region. A Security Issue". Valencia
- García, J. et al. (1997). Detection of forest burning sites with NOAA-AVHRR. Trial of a forward method. En: A review of remote sensing methods for the study of large wildland fires. E. Chuvieco (Ed). Megafires project ENV-CT96-0256. Universidad de Alcalá de Henares

Norut - Northern Research Institute Tromsø AS (www.norut.no) P7

Qualification and capacity

Norut is an independent, non-profit, multi-disciplinary research institute majority-owned by the University of Tromsø, focusing on technology (Earth Observation, Information and communication Technology, Biotechnology) and social science research and innovation. Norut carries out research commissions for industry, business and the public sector. Its mission is to be a tool for refinement and further development of innovative ideas coming from the University, our own researchers and our contract partners. The Earth Observation group has about 15 scientists and its main focus is on synthetic aperture radar processing and applications. Norut is a leading institute in developing prototype operational SAR monitoring systems for snow cover, flood, sea ice, ocean and geohazard monitoring. In 2001 Norut was appointed as an ESA Expert Support Laboratory by the European Space Agency, and has lead and participated in several ESA and EU projects (see reference project list). Since 2008 Norut is involved in research on rainforest monitoring in cooperation with the Brazilian Institute for Space Research (INPE).

Selected reference projects:

- EuroClim - European system for monitoring and prediction of climate changes, 2001-2004, contract nr. EU-IST-2000-28766, http://euroclim.nr.no/ .
- EnviSnow - Development of Generic Earth Observation Based Snow Parameter Retrieval Algorithms, EU FP 5 project, 2002-2005, contract nr. EVG1-CT-2001-00052, http://projects.itek.norut.no/EnviSnow/
- EnviWave - Development and Application of Validated Geophysical Ocean Wave Products from ENVISAT ASAR and RA-2 Instruments, 2002-2005, EU contract nr. EVG1-CT-2001-00051.
- FloodMan - flood forecasting, warning and management system, EU FP5 project 2003-2006, contract nr. EVG1-CT-2002-00085, http://projects.itek.norut.no/floodman/ .
- PolarView – Earth Observation for polar Monitoring, 2005-2008, ESA & EU GMES Service Element, http://www.polarview.org/ .
- IMAR - Integrated EO based Monitoring Services for the Arctic Region, 2008-2011, ESA project.

Key scientific / technical personnel

Jörg Haarpaintner, Dr. in Physical Methods for Remote Sensing (Senior scientist, M). Expert in the use of SAR for operational monitoring with a 12-year background in polar research and active microwave remote sensing. Since 2005, main developer and, therefore, extensive knowledge of Norut's prototype operational SAR monitoring system. He has also education and a strong interest in sustainable development and carbon accounting of forests. Jörg initiated the cooperation with INPE and will be responsible for the overall science content of Norut in this project.

Eirik Malnes, Dr. in space plasma physics (Senior scientist, M). Expert in various applications of SAR, including physical modeling of scattering mechanisms and statistical signal processing in connection with earth observation. He has lead two EU FP5 projects under which the SAR monitoring system has been developed and several ESA and national funded projects related to cryospheric monitoring. Malnes has been a member of the Mission Assessment Group for CoRe H2O since 2005.

Yngvar Larsen, Dr. in Physics (Senior Scientist, M). Expert in SAR processing and SAR interferometry.

Stein Rune Karlsen, Dr. (senior scientist, M), Stein Rune Karlsen is a plant ecologist with substantial experience in environmental monitoring. Currently his main work is within satellite-based study of the seasonal dynamics of vegetation (phenology) and climate change impact on vegetation.

Selected relevant publications:

- Haarpaintner, J., Adapting the ice-ocean SAR discrimination algorithm to dual-polarized Radarsat-2 imagery. Norut IT Report 06-2009, Tromsø, Norway, ISBN 978-82-7492-214-3, 55 pages, 2009.
- Haarpaintner, J., R. Almeida-Filho, Y.E. Shimabukuro, E. Malnes, and I. Lauknes, Comparison of Envisat ASAR deforestation monitoring in Amazônia with Landsat-TM and ALOS PALSAR images. Anais XIV Simpósio Brasileiro de Sensoriamento Remoto, Natal, Brasil, 25-30 Apr 2009, INPE, 5857-5864, 2009.
- Haarpaintner, J., E. Malnes, R. Almeida-Filho, Y.E. Shimabukuro, and I. Lauknes, Operational SAR Monitoring: From Snow to Tropical Rainforest. Proceedings of the 33rd International Symposium on Remote Sensing of Environment, Stresa, Italy, 4-8 May 2009, 4 pages, 2009.
- Solberg, R., E. Malnes, J. Amlien, F. Danks, J. Haarpaintner, K.-A. Høgda, B. E. Johansen, S.R. Karlsen, and H. Koren. State of the art for tropical forest monitoring by remote sensing - A review carried out for the Ministry for the Environment of Norway and the Norwegian Space Centre. NR-Report 1020, NR, Oslo, Norway, Sep 2008.

Wageningen Universiteit (WU), The Netherlands P8

Brief description of the organisation

WU & Research Centre (WUR) (www.wur.nl) in the Netherlands is a top research and education institute (with about 6000 employees) and belongs to the international top 3 in the field of agriculture and top 5 in the field of environment (in terms of citation index). The Centre for Geo-Information (CGI) includes the remote sensing chair group led by Prof. Dr. Martin Herold. The group specializes in the domain of quantitative, physical and statistical based retrieval of land surface parameters relevant for Earth System Science, and land monitoring and assessments for a number of applications. There is have long time experience in land use and land cover mapping and monitoring using Remote Sensing global (GLOBCOVER), regional and local land cover activities. Alterra is part of the Centre and has experience with CORINE land cover and its update in using high-resolution satellite data. The Alterra group of CGI leads the MARS project and participates in GEOLAND.

Selected reference projects

- Land Use and GHG emissions - FP 7 project on European land use changes and impact on GHG budgets, 2009-1012.
- CIFOR Global REDD - Global comparative study for REDD, funded by Government of Norway through CIFOR, 2009-2012
- REDD capacity - REDD MRV capacity assessment for 150 non-Annex I countries, Princes Rainforest Project & Norway, 2009, http://princes.3cdn.net/8453c17981d0ae3cc8_q0m6vsqxd.pdf
- Vanuatu Carbon Credits Project - Build capacity in Vanuatu to utilise carbon markets to help reduce emissions from deforestation and forest degradation, funded by British High Commission, 2007-08, http://www.victoria.ac.nz/geo/research/climate-change/vanuatu-forests/

Short profile of key staff

Prof. Dr. Martin Herold is chair of remote sensing at Wageningen University. He leads the Global Observations of Forest Cover and Land Dynamics (GOFC-GOLD) of UN (GTOS) and has been coordinating the ESA GOFC GOLD Land Cover project office 2004-2009. He is an expert for large land cover and forest monitoring systems in the context of UNFCCC (GCOS implementation plan and reducing emissions from deforestation-REDD), GEO, GLOBCOVER, and FAO's FRA 2010 remote sensing survey. He is one of the leading experts on REDD MRV and has worked for UNFCCC secretariat, FAO, Worldbank, CIFOR and several national governments including Norway, Germany, New Zealand, Guyana and Fiji.
Dr. Jan Clevers has been a member of Wageningen University since 1981, where he conducts research towards the application of remote sensing in environmental sciences. His present activities concern the continuation of the developments, i.e. forthe synergy hypothesis with the purpose of the combined use of optical and microwave observations and of prior knowledge, and land cover mapping using remote sensing data at different scales.
Dr. Dirk Hoekman works at Wageningen University since 1981 and is one of the world leading experts of SAR remote sensing of tropical forests**.** He was scientific co-ordinator for the ESA/INPE Amazonian expedition (1986) and the ESA/JRC AGRISCATT campaign (1987-1989); co-ordinating investigator for the international test site Flevoland for the JRC/ESA MAESTRO-1 campaign (1989-1991) and for the tropical rain forest sites in Colombia and Guyana with recent emphasis on use of JAXA's ALOS PALSAR data.
Dr. Harm Bartholomeus is assistant professor, after obtaining his PhD from Wageningen University entitled: 'The influence of vegetation cover on the spectroscopic estimation of soil properties' (2009). He has experience combining field measurements and remote sensing data for calibration and validation purposes.

Key references:

DeFries, R., Achard, F., Brown, S., Herold, M., Murdiyarso, D., Schlamadinger, B. and C. De Souza (2007). Reducing greenhouse gas emissions from deforestation in developing countries: considerations for monitoring and measuring, Environmental Science and Policy, 10, pp. 385-394
Herold, M. & T. Johns (2007). Linking requirements with capabilities for deforestation monitoring in the context of the UNFCCC-REDD process, Environmental Research Letters, 2, 045025 (7 pp), online access: erl.iop.org.
Herold, M., Woodcock, C., Mayaux, P., Baccini, A. and C. Schmullius (2008). Some challenges in global land cover mapping: an assessment of agreement and accuracy in existing 1 km datasets, Remote Sensing of Environment, 112, 2538–2556.

Brazilian Institute for Space Research INPE P9
INPE's mission is to promote and carry on studies, scientific researches, technological development, and human resources capacitation, in the fields of Space and Atmosphere Sciences, Space Applications, Meteorology, and Space Engineering and Technology, as well as in related domains, in accordance with the policies and guidelines set forth by the Brazilian Science and Technology Ministry. INPE works also in close cooperation with the Brazilian Ministries of Environment (IBAMA) and Agriculture (EMBRAPA). INPE is the international leading institute in operational rainforest monitoring, with two decades of experience in this area, acquiring important data sets of the Amazon through PRODES and DETER.

Yosio Edemir Shimabukuro: Currently, I am involved in several projects in Amazon region as part of Terrestrial Ecosystem Program of Remote Sensing Division at INPE. These include: (1) Deforestation Project – monitoring of deforested areas in Brazilian Amazon using manual and digital interpretation of Landsat TM data; (2) DETER Project – detection of deforestation areas in a near real time using MODIS data; (3) Mapping and monitoring land cover in Mato Grosso state, Brazil. Also, I have been involved in several projects in the vicinity of Tapajós National Forest, as part of LBA and RADARSAT.
Raimundo Almeida-Filho: My main interest in such a kind of study is to define the actual effectiveness of using SAR data as the basis for a regional-scale operational program to monitor deforestation in the Amazônia. In this context, dual-polarized SAR data, obtained under a systematic repetitive acquisition strategy, may constitute an effective tool to cope with this task. In addition, there is the necessity of an automatic procedure to analyze huge mass of multitemporal radar data, and organize them in a georeferenced database to facilitate access and integration with other sources of data.
Tatiana Mora Kulpich: Since 1994 works with the remote sensing of Brazilian Amazonia, mainly using SAR data. PhD. in Geography with thesis on the radar remote sensing of regenerating tropical forests. Had also worked for a review of the PRODES data for Acre State. The Tapajós National Forest and surroundings are her preferred study site, also for the project on mapping land use with RADARSAT-2 polarimetric data. In 2008 moved to the INPE's Southern Regional Centre (CRS), at the very South of Brazil (Santa Maria, in Rio Grande do Sul State), where started working with temporal dynamics and biomass/productivity of grasslands ecosystems with support of remote sensing data. Her main interest is on the use of remote sensing data and methods for assessment, monitoring and conservation of threatened terrestrial ecosystems.

Key references:
1)Espírito-Santo, F.D.B.; Shimabukuro, Y.E.; Kulpich, T.M. Mapping Forest successional stages following deforestation in Brazilian Amazonia using multitemporal Landsat Images. International Journal of Remote Sensing, vol.26, no.3, 635-642, 2005.
2)Shimabukuro, Y.E.; Almeida-Filho, R.; Kulpich, T.M.; Freitas, R.M. Quantifying optical and SAR image relationships for tropical landscape features in the Amazônia. International Journal of Remote Sensing, v. 28, p. 3831-3840, 2007
3)Shimabukuro, Y.E.; Almeida-Filho, R.; Kulpich, T.M.; Freitas, R.M. Mapping and monitoring land cover types in Corumbiara area, Brazilian Amazônia, using Landsat TM and JERS-1 SAR multitemporal data. Revista Ambiente e Água, v. 3, p. 34-41, 2008.
4)Almeida-Filho, R.; Rosenqvist, A.; Shimabukuro, Y. E.; Sánchez, G.A. Using dual-polarized ALOS PALSAR data for detecting new fronts of deforestation in the Brazilian Amazônia. International Journal of Remote Sensing, v. 30, p. 3735-3743, 2009.
5)Almeida-Filho, R.; Rosenqvist, A.; Shimabukuro, Y. E.; Silva-Gomez, R. . Detecting Deforestation With Multitemporal L-band SAR Imagery: a Case Study in Western Brazilian Amazônia. International Journal of Remote Sensing, v. 28, p. 1383-1390, 2007
6)Almeida-Filho, R.; Rosenqvist, A.; Shimabukuro, Y. E. ; Santos, J. R. Evaluation and Perspectives of Using Multitemporal L-Band SAR Data to Monitor Deforestation in the Brazilian Amazônia. IEEE Transactions on Geoscience and Remote Sensing, U.S.A., v. 2, n. 4, p. 409-412, 2005
7)Luckman A., Baker J., Kulpich T.M., Yanasse C.C.F. & Frery A. (1997). A study of the relationship between radar backscatter and regenerating tropical forest biomass for spaceborne SAR instruments. Remote Sensing of Environment, 60, 1-13.
8)Kulpich T.M., Curran P.J. & Atkinson P.M. (2005). Relating SAR image texture to the biomass of regenerating tropical forests. International Journal of Remote Sensing, 26, 4829-4854.
9)Kulpich T.M. (2006). Classifying regenerating forest stages in Amazônia using remotely sensed images and a neural network. Forest Ecology and Management, 234, 1-9.

2.3 Consortium as a whole

The consortium has nine partners of which two are private enterprises (one SME), five research and development organizations, and two universities. Thus, the whole chain from the basic research to professional product delivery capabilities is available within the consortium (Table 2). Most of the partners are already internationally recognized actors in remote sensing applications in forestry, including experience on operative service provision.

The project is highly-interdisciplinary which secures together with close user interaction that it meets the objectives. The project staff contains includes forest inventory experts, statisticians, software engineers, optical and microwave data processing and analysis experts including experts of object oriented approaches, business developers from the private sector, a coordinator of an international network, lidar data analysis specialists, GIS and INSPIRE specialists. The area representativeness is also excellent. We have six users from three continents, three project partners from International Cooperation Countries. These Mexican and Brazilian partners are close to the users ensuring smooth communication with the users also with their own language. The service cases are located in countries that are in the frontline of REDD: Mexico, Brazil, Guyana, Fiji, and Democratic Republic of Kongo (through OSFAC). The users will participate in project meetings. We plan to have one meeting in each user’s home country. In addition to the identified partners, we have a specific work package for the expansion of the services.

The partner roles in WPs shown in the Implementation Plan have been carefully considered to match partner skills to the thematic elements. Through providing skills and expertise in relation to these themes, the consortium provides a strong and complementary partnership that permits the objectives of ReCover to be met.

Table 2. Partner role and technical skill summary.

SKILL ITEM	VTT	ALU-FR	Arbonaut	GMV	NORUT	WU	COLPOS ECOSUR	INPE
Project coordination	x							
Work package coordination	x	x		x	x	x		
Direct links with users / user interaction	x			x	X	X	X	X
Forest cover and change	X	X	x	x	X	X	x	X
Biomass	X	X	X	x	x	x	x	
Carbon sequestration		X		x			X	X
Socio-economic integration	x			X		x		
VHR optical	X		x	x	x			
Medium resolution wall-to-wall optical	X		x	x	x	X		x
Statistical methods	X	x	x			x	x	
Change detection	X	x			x	X		x
SAR backscatter, Polarimetric SAR and signatures	X	x			X	x	x	x
Interferometric SAR, coherence	x	X		x	x		x	
Lidar (airborne / spaceborne)		X	X	x		x	x	
Multisensor data fusion	X	X	x	x	x	X	x	x
New techniques	x	X						
GIS-based information system	x			X		x		
Inspire compatibility				X				
Business model development	x		x	x	X	x		

Table 3. Mobilization of the resources in ReCover.

nbr	Short name	Expertise contributed to the project	Role in ReCover	Resources: personnel
1	VTT	Management – VTT also has an experienced EU-project management support team, Forest inventory expertise, Optical and microwave processing and analysis methods and software, VHR image analysis techniques, Sampling techniques and statistical approach, Multi-sensor techniques, Microwave data processing and analysis methods and software, Dissemination, Service validation, New sensors and techniques, Service roll-out and expansion	▪ Project coordination ▪ Service development and provision ▪ Mexican users together with local partners ▪ WP leader	64 person months
2	ALU-FR	Forest inventory expertise, Carbon sequestration, New sensors and techniques, Sampling techniques and statistical approach, Lidar techniques, Multi-sensor techniques, Microwave data processing and analysis methods and software	▪ Service development ▪ Participation in service provision ▪ WP leader	45,5 person months
3	Arbonaut (SME)	Forest inventory expertise, Lidar techniques, Multi-sensor techniques, Sampling techniques and statistical approach, Dissemination, Service roll-out and expansion, Service validation	▪ Service development ▪ Participation in service provision	15 person months
4	COLPOS	Forest inventory expertise, Sampling techniques and statistical approach, Carbon sequestration, Multi-sensor techniques, SAR interferometry, Microwave data processing and analysis methods and software, Lidar techniques, Service expansion	▪ Service development and provision ▪ Mexican users together with VTT	22 person months
5	ECOSUR	Forest inventory expertise, Sampling techniques and statistical approach, Carbon sequestration, Multi-sensor techniques, SAR interferometry, Microwave data processing and analysis methods and software, Lidar techniques, Service expansion	▪ Service development and provision ▪ Mexican users together with VTT	17 person months
6	GMV	Socio-economic integration, GIS-based information system, Inspire compatibility, Multi-sensor techniques, SAR interferometry, Carbon sequestration , Optical and microwave processing and analysis methods, Dissemination, Service roll-out and expansion	▪ Service development ▪ Participation in service provision ▪ WP leader	42 person months
7	Norut	Microwave data processing and analysis methods and software, Service roll-out and expansion, Service validation, Multi-sensor algorithm, SAR geocoding, SAR interferometry	▪ Service development and provision ▪ WP leader ▪ Brazilian user ▪ User from Congo	35 person months
8	WU	Forest inventory expertise, Cooperation with developing countries on forest monitoring, User advocacy and capacity building in	▪ Service development and provision ▪ International coordination	45.5 person months

		tropical regions, Monitoring for REDD and LULUCF in developing countries, Processing of optical and SAR data for forest change monitoring, Accuracy assessment techniques, Service expansion	▪ Fiji user ▪ Guyana user ▪ WP leader	
9	INPE	Forest inventory expertise, Multi-sensor techniques, Optical processing and analysis methods, Carbon sequestration, Service expansion	▪ Service development and provision ▪ Brazilian user together with Norut	12 person months

2.4 Resources to be committed

The role and effort of each participant has been defined based on the objectives and the implementation plan. Resources to work packages have been allocated based on the expertise of each participant. Management has been kept to a level consistent with the size of the project and the goals of the consortium. The planned budget for the partners is shown in Table 4. The total budget is 3585 k€ with EU contribution of 2500 k€.

Table 4. Planned budgets for the partners

Partner	RTD activities	Demonstration	Training	Management	Other activities	Total	EU funding
VTT	503 675 €	260 725 €	28 925 €	177 170 €	84 600 €	1 055 095 €	798 814 €
ALU-FR	297 800 €	196 000 €	15 200 €	- €	22 400 €	531 400 €	358 950 €
Arbonaut	58 400 €	36 000 €	9 700 €	- €	14 400 €	118 500 €	85 900 €
COLPOS	48 600 €	19 200 €	6 000 €	- €	- €	73 800 €	52 050 €
ECOSUR	48 800 €	17 280 €	7 680 €	- €	- €	73 760 €	52 920 €
GMV	301 067 €	149 803 €	15 581 €	- €	42 685 €	509 135 €	283 700 €
Norut	333 400 €	163 400 €	57 200 €	1 500 €	5 000 €	560 500 €	395 450 €
WU	365 691 €	167 873 €	24 055 €	1 500 €	45 218 €	604 337 €	428 977 €
INPE	40 000 €	12 800 €	6 400 €	- €	- €	59 200 €	42 800 €
Total	1 997 433 €	1 023 081 €	170 740 €	180 170 €	214 303 €	3 585 727 €	2 499 562 €

The partners that are responsible for the service provision have budgeted 10 000 euros for each user to participate in project meetings and another 10 000 euros for support to collect ground reference data. However, in Mexico with two users the travel support is 15000 euros but the field data support is the same 10 000 euros as in the other service locations. The users need support to organize field data for the project because their resources are very limited. On the other hand the economic benefit from the ReCover project takes some years to support the sustainable forest management and several years for REDD to realize. Money has also been allocated user training related costs, like partners travelling to the user countries to keep the trainings, consumables needed for the trainings and rent of the place were the training will be kept. Training is needed to ensure that the users can fully exploit the products, are able to do the user validation and can give feedback to the consortium. This also contributes to the capacity building in the user countries.

Some ancillary and image data is available from the members of the consortium and the users. All the products delivered by the consortium are listed in Annex 1 (List of products delivered by the ReCover project) and the ancillary data has been listed in Annex 2. Image data, which has been listed in Annex 1 (List of products delivered by the ReCover project) but not in Annex 3 (Summary of the requested EO data) is already available inside the consortium. It is expected that the data requested will be made available by ESA on the basis of the GSC-DA. Data needed for each test site has also been specified in Annex 4 Service requirements. In the budget, some money has also been reserved for image data handling costs. Subcontracting needed by ALU-FR has been described in Annex 6.

There are also parallel projects running in the user countries which also benefit ReCover. For example in the Republic of Congo, there will be a project called Biomass measurements for the carbon stock estimation

(CBFF project). Quantify the forest carbon emissions from land use change (forest loss and degradation) will be evaluated using the most up-to-date methodologies and following IPCC Good Practice Guidance. Ground reference data collected for this project will be made available for ReCover as well. Through GEO project, the user can also make available lidar, Alos Palsar and in-situ data. Also socio-economic data has been collected in the study area and it can be analysed in ReCover. In addition to possibilities of sharing data, also results of this kind of parallel projects will be followed in each user country.

Software developed in ReCover will be partly based on the software already available in the consortium. Besides in-house software, also commercial software is available for use in this project and it has been listed in more detail in Annex 7.

3 Impact

Mapping tropical forest by satellites has been studied extensively since 1980'ies. Forest biomass and degradation are much less studied subjects in general and in the tropical forest areas in particular. Just recently attention is paid on applying a solid statistical concept in the surveys like in FRA2010 but still the statistical approach is in early development stages. Change detection and the evaluation of accuracy of change maps needs improvement. Radar image analysis has on one hand very high expectation for tropical forests but state-of-the-art research has revealed some concerns concerning radar potential. The role of radar should be further defined. Better standardization of the services is needed to make them accepted by the operative community. Finally, capacity building actions are required for different types of users some of which requiring improved skills in specific areas such as radar image analysis whereas for some users the capacity building has to be started from a more basic level.

New forest change and forest degradation services in GMES will have strong impact on the possibility to monitor reduction of greenhouse gas emissions from tropical forests in connection with the REDD mechanism of the UNFCCC process. When successfully implemented over large areas this reduction of greenhouse gases in turn has a great impact on the outlook of society to overcome challenges imposed by climate change. Simultaneously the services support practising of sustainable forest management.

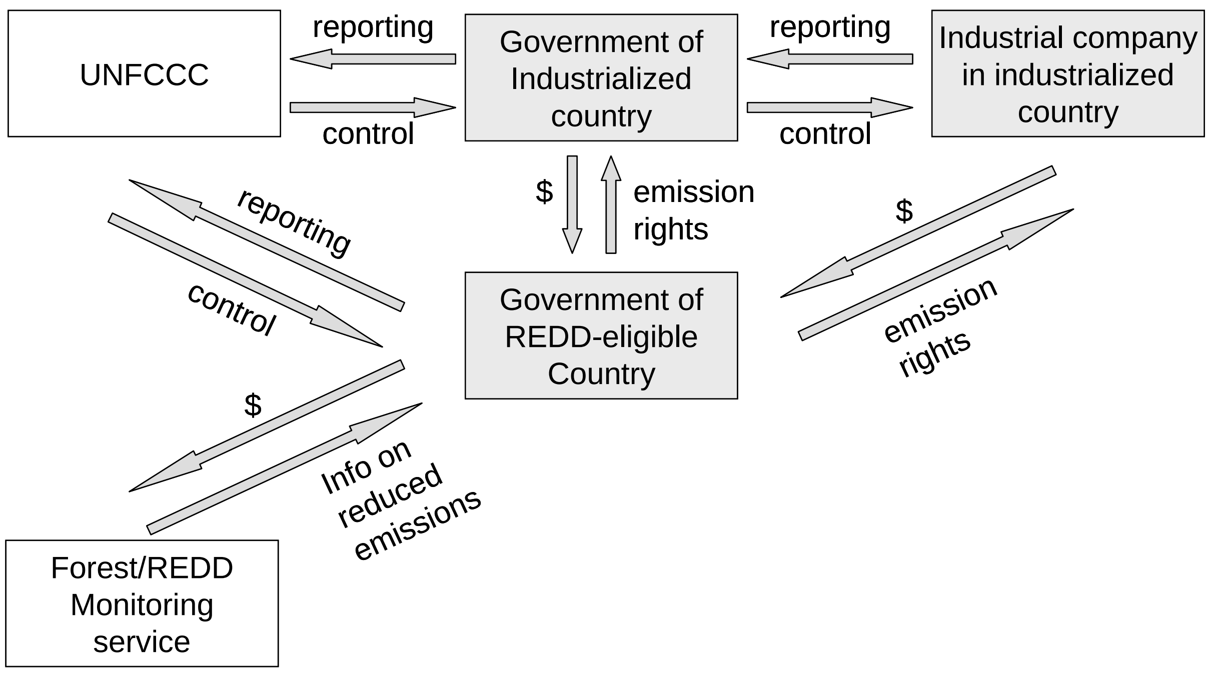

Figure 8. Actors in the REDD mechanism of UNFCCC (schematically).

Table 5. Expected impact and ReCover contribution.

Expected impact in the call	Contribution of the proposal
"The project is expected to establish innovative new GMES services responding to user needs"	The ReCover project will develop and demonstrate services that reach beyond state-of-the art by – Focusing on variables of interest having high relevance to REDD and sustainable forestry (degradation, biomass, continuous crown closure – adapted to several definitions of forest), – Applying innovative technological solutions (combination of sample of VHR and wall-to-wall optical and radar data), – Using image analysis algorithms (including in-house object oriented approaches), – Having a statistical concept throughout the whole approach, – Developing a novel and standardized information technology solution – Cooperating with a large and versatile user community from very experienced to less experienced users; from governmental bodies to international cooperation organizations.
"…clear impact on the operations and achievements of the involved user communities. The projects are expected to show significant uptake of products".	Recover services deliver altogether 57 products that are based on Service Level Agreements (SLA) between the service providers and the users. The users have defined the service content by themselves, which has led to some variability in the service contents. The variability is one indication on the foreseen significant benefits from the services. Another indication is three signed users from Mexico. Two more users wanted to join the consortium in addition to the principal user after getting acquainted with the project. The users with one exception are directly serving the governments of REDD-eligible countries (Figure 8). One user the OSFAC in Africa, is a cooperation network of several organizations. Thus the users, who are directly coupled to the REDD mechanism of the UNFCCC, can have a direct supervising and directing mechanism to influence the developed GMES services via these SLAs. Two work packages, WP 2300 "User Training and Capacity Development" and WP2400 "Product Validation by Users" specifically focus on ensuring the uptake of the products.
"Strategies for achieving long-term sustainability should be evident" "The evolution and trends of future sensor needs shall also be demonstrated"	One major work package WP3000 with two sub-packages WP3100 "Service Consolidation opportunities" and WP3200 "Dissemination" is established to support the strategies for long-term sustainability. WP3000 is not only concentrating on the present users but expansion of the services to new users and user communities is in the core of the WP. Interaction with the users and between the users is one important aspect to ensure long-term service sustainability. WP1100 "User Interaction and International Commitments" supports continuous cooperation particularly with the present users. The user community has reported repeatedly to the satellite data providers that sustainable remote sensing services are only feasible when sustainable data supply guaranteed. The ReCover project will support data sustainability through WP1400 "New Sensors and Techniques". The work package will evaluate the upcoming or recent missions such as the Sentinels and several national programs from the viewpoint of the operative services. It also will give recommendations for the

	future space missions.
"Progress to establishing a directory of potential users likely to be willing and capable to pay for the services in the future."	The directory will be prepared in WP3100 Service Consolidation Opportunities. Already the present consortium has an excellent knowledge on the potential user community in addition to the large user community since it includes GOFC-GOLD coordinator and a key GEO actor, partners of GSE Forest Monitoring project and the major African cooperation network OSFAC. A specific road show to southern Africa to present the project and future service opportunities is budgeted. A typical customer to a service provider is a government of a REDD eligible country as can be seen in Figure 8. However, it may be possible that the funding is originated from an industrial country that is willing to buy carbon credits through the REDD process. Information of the new users is not only collected via the consortium network. The project aims at high visibility in the international *fora* such as the Conference Of the Parties (COP) of the UNFCCC. Also the web pages and their active promotion is an important tool to start the user dialogue.
"The results obtained shall contribute directly to the sustainability and competitiveness of European value adding services and SME's."	The ReCover consortium is well balanced between the service provider companies of which one is a SME, research and development organizations, and the academia. Thus, the chain from the basic research through product development to commercial service provision is inherent in the consortium. The composition of the consortium makes it possible that the value adding companies can utilize most recent scientific advances in their services. The research organizations can and will in the short term act as service providers. In ReCover the one partner is responsible for the delivery of the service but the services are contributed by several partners to secure that the best beyond state of the art expertise is available in this research project. As soon as the services mature they can either be licensed to the service providers within the consortium, outsourced to the users in-house (these two alternatives are of first priority) or to third party service providers. The service arrangement in ReCover secures that the consortium can provide the services also after the completion of the research project and consequently have a long-term impact globally in forest monitoring. The sustainability and competitiveness of the value adding sector, including the SME in the consortium comes not only from networking with the research partners. It also comes from networking with the current users of the services and new users that are interested in the services trough the activities in work package 3000 Service roll-out and expansion.
"…impact … in a socio-economic context, and in particular demonstrate the European added value" "… close collaboration with representative user	The REDD process leads to less greenhouse gas emissions, which improves the societies' chances of overcoming the challenges imposed by climate change. The core motivation of the REDD eligible countries on remote sensing based monitoring system is to demonstrate the effect of a REDD project in an objective manner. A proven reduction of emissions from forest can be turned to income through selling of carbon credits. The more accurate the monitoring system is the

communities throughout and possibly outside Europe is essential”	higher income can be gained. Increased income will improve the economy in general and it can be used to benefit people in local communities that are affected by REDD. The ReCover project does not consider REDD only but it concerns the development of sustainable forest management system more generally. Actually the variables that are of interest in ReCover and the general concept of the monitoring system can be used also for purposes other than the REDD. Sustainable forestry means sustainability of forest industries and land use, which offers secure income for people in the long term. Presently over-cutting and poor forest management cause economic problems and discontinuing income for the local people. Socio-economic aspects are studied in WP1200 of ReCover. Although the investments on space technology in Europe are only one tenth of those in the United States, Europe may have had a more strategic approach in the development of the value adding services. The ReCover project implements the successful strategy in locations outside Europe. Realization of ReCover strengthens the competitiveness of European value adding sector in the tropical region thus widening the market world wide. INSPIRE compatibility of the services in ReCover advances European service providers' competitiveness in future operative services. All the six users and three partners of ReCover are outside Europe. Both parties are needed to make the project successful. Tight cooperation and mutual benefit form a good foundation for continuing the cooperation also after the ReCover.
“The projects are expected to take into account and build upon relevant past and ongoing activities in the field.”	The most important past and ongoing activities that are relevant to ReCover are TREES 3 project, FRA2010, and GSE Forest Monitoring with its extension. GEO has established six national demonstrator countries in 2009 with a series of sub-national verification sites across the World to study forest change and carbon using space-borne remote sensing and other data. Three ReCover study sites are located in the demonstration countries, *i.e*. Mexico, Guyana and Brazil. From the technological viewpoint the GMES core projects, Geoland2 in particular, and the downstream projects are relevant. TREES3 and FRA2010 apply a similar sampling methodology where optical Landsat (and Spot) data are the most accurate remote sensing information sources (and the most accurate information sources in general). Both projects focus on land cover and land cover change mapping using optical imagery. In TREES3 automatic methods for the mapping are developed. The GSE Forest Monitoring focuses on smaller regions than the global or continental level TREES3 and FRA2010 projects. The application area is forest cover and forest cover change. The coordinator of ReCover, VTT participated in the GSE Forest Monitoring project with application in French Guiana where wall to wall radar image mapping and a sample of Landsat and data was applied for forest cover and forest cover change monitoring. University of Freiburg had a European forest cover mapping case. The TREES3, FRA2010 and the GEO forest activities are well known to the project coordinator and GOFC-GOLD coordinator who participates in the consortium. Project coordinator is participating in Geoland2 as key developer of

	novel methods for forest cover and crown closure mapping. Another activity, JAXA-led Kyoto Carbon Initiative is set out to produce global SAR image mosaics over most of earth's land mass annually. The mosaics' applicability will be evaluated for ReCover. However, the global products have often had quality problems which limit their use for numerical interpretation. Also the resolution of the used PALSAR instrument is relatively coarse for reliable forest (degradation) mapping. The consortium thus knows the ongoing activities and the state of the art already from inside the projects, which made it possible to direct ReCover to find solutions to the most serious challenges, i.e. the biomass, degradation, accuracy of principal data and the statistical approach including combination of the different data sources. ReCover aims at Tier 3 level information unlike the previous projects that aim at level 2 at highest. The dialogue with the ongoing other activities will not be restricted to partner involvement in other projects but a more formal communication is organized through the GOFC-GOLD project office and associated activitiesin Work Packages 1100 and 3100.
"The impact of the validated system should also be demonstrated through pilot tests and exercises…"	The services, defined in the SLA's will be performed on REDD compatible sites under a statistical framework that enables computation of the accuracy figures in a coherent and transparent way. They are delivered through a standardized system that will be developed in WP1300 Product Chain Adaptation and validated by the users in WP2400.

Impact by Actor Groups

Service users identified in the ReCover project proposal

The original users who are involved in activities of project ReCover from the beginning of the project gain the following major benefits:

- cost effective methodologies for producing information on emission reductions in REDD projects,
- opportunity to influence the development of monitoring methodologies in an early research and development project.

Service users adopting the ReCover services during or after the project

The follow-on users – who are presumably attracted to the services developed in project ReCover as a result of activities of WP 3000, Service Roll-Out and Expansion - gain the following major benefits:

- cost effective methodologies for producing information on emission reductions in REDD projects,
- less involvement and work load in service definition than the original users.

Service sector

The service providers in the ReCover consortium gain the following major benefits:

- cost effective services to offer to actors in the UNFCCC REDD process,
- services to serve as a basis for method development in other forest-related applications,
- competitiveness in service development
- network to science and customer sector

Society as a whole

The impact from project ReCover for societies come from within the UNFCCC REDD process and outside it:

- major benefits through the REDD process:
  - reduced greenhouse gas emissions, which leads to slowed-down climate change and better opportunities for society to adapt to the negative effects of climate change,
  - opportunities for industries to survive with the help of increased emission rights from the REDD process,
- possibilities to better monitor world's forests and their status.

3.1 Dissemination and/or exploitation of project results, and management of intellectual property

The dissemination of the project results is very important and essential to achieving the envisaged project impacts. Dissemination will be based on a detailed dissemination plan drawn up early in the project (WP 3200, Dissemination). A periodic review (once per year) followed by a continuously updated plan, will ensure the high quality and relevance of all dissemination activities. All dissemination material will respect the consortium agreement and in particular the confidentiality of data supplied by partners and users.

Dissemination Objectives

The objectives of the ReCover dissemination are to:

- Increase awareness of the project, its objectives and achievements
- Inform target groups about results from the project
- Involve and gain feedback from participants of the UNFCC REDD process and other users of the developed services
- Coordinate with other projects and networks
- Cooperate with standardisation bodies

An early involvement of users of the developed services and other REDD stakeholders in the drafting of the ReCover dissemination plan will ensure a faster and more efficient dissemination of project results.

The ReCover dissemination plan will comprise the following:

- Clear identification of the major target groups and the best channels to reach them
- Definition of the customised dissemination material
- Definition of the dissemination routes, including effective ways to collect feedback
- Definition of the measures of success for dissemination
- Detailed scheduling and distribution of the dissemination actions among partners

Target Audience

The target audience for dissemination includes:

- Major international stakeholders for project ReCover are delegates in UNFCCC conferences of parties and their advisors, delegates in the UNFCCC SBSTA and their advisors, and staff in United Nations and other international organisations connected to the work of UNFCCC like World Meteorological Organisation or European Space Agency
- Environmental organisations (governmental and NGOs, e.g, WWF)
- Researchers from academia (forestry, agriculture, supply chain, surveying)

- Major REDD stakeholders at the national level like ministries responsible for reporting to UNFCCC and related national institutions where reporting obligations or parts of them have been delegated
- Companies and government offices in sectors connected with utilisation of natural resources
- Parallel REDD-related development projects

<u>Means to be used for dissemination</u>

Direct Dissemination

Representatives from major REDD stakeholders will be contacted directly. This group includes delegates in UNFCCC conferences of parties and their most important advisors, persons participating in the work of the SBSTA, and persons responsible for UNFCCC reporting in governments. The direct communication with major REDD stakeholders makes use of newsletters and press releases as well as links to the web site of project ReCover.

Project Web Site and Web Portal

A project website will be established within the first month to provide the forum for dissemination of the results, papers, and information about the project. All public deliverables will be available at this site. The website will be available in English. A project summary will be also available in the respective national languages of the users (Spanish, Portuguese and French). The website will include the services needed to support an exchange of information between partners and stakeholders.

Dissemination material

General dissemination material (flyers, posters and articles etc.) will be prepared and delivered at different events, seminars, press media etc. All material will be published in English and if needed a selection of the material for national target groups, in the respective national language to ensure that all target groups will be able to access the results.

Presence at major stakeholder events

The project will be disseminated through presentations and promotional material at major events like the technical side events of UNFCCC conferences of parties. As the monitoring methods for the REDD mechanism of UNFCCC are in a continuing development process, these events form a good opportunity to influence the future development of monitoring methodologies. These events also serve as an input to steering the scientific and technical development in project ReCover towards a unified set of widely approved monitoring practices.

Project Workshops

Some of the most important REDD stakeholders and user group representatives will be invited to workshops following one mid-term meeting and the final project meeting. During the workshops the invited user groups will be informed about the project results. In addition, national workshops will be held in user countries if the participants identify the opportunity.

Scientific conferences

The results will be presented at international conferences to provide a wide forum for dissemination, and to offer a common forum for the entire international scientific community and REDD stakeholders. Appropriate conferences will be identified during the project.

Involvement with scientific bodies

By informing scientific bodies on project results it will be possible via these communication channels to reach a larger number of interested parties. The scientific bodies include international organisations like IUFRO (International Union of Forest Research Organizations), ISPRS (International Society for Photogrammetry and Remote Sensing), and IEEE (Institute of Electrical and Electronics Engineers) and their regional and national member organisations.

Scientific papers in peer reviewed journals

Scientific papers written during the project will inform the scientific community in peer-reviewed journals. Appropriate journals (such as Remote Sensing of Environment) for publishing results from project ReCover are selected during the project. As the topic area of forest degradation has not attained much attention in science communities around earth observation we aim at least five peer-reviewed articles are written on findings of project ReCover.

Regular news feeds into public information channels

Professional press releases will be placed in major professional and online journals. Articles for professional journals will be written by partners for a national and international audience. Articles and the press releases for wider audience will be taken care of by a professional media officer.

Overview of Intellectual Property (IP) opportunity:

Management of IP: As recommended in FP7 guidelines and according to standard practice, IP will be considered in the following categories:

- Background (pre-existing IP)
- Foreground (knowledge generated from the Collaborative Project whether or not it may be patentable)

Foreground may be owned by the single party that generated the Foreground or jointly owned by several parties that have contributed to the Foreground. The ownership and rights of use of Foreground generated through the performance of this collaborative project will be defined in the consortium agreement, which will combine standard practice with specific cases to enhance the effectiveness through which Foreground can be exploited and/or commercialized. Software already available in the consortium has been listed in Annex 7, but more detailed lists will be done for the consortium agreement.

4 Ethical Issues

All participants in ReCover will conform to current legislation and regulations in the countries where the research will be carried out. In the ReCover project there are no conflicting ethical issues according to the table below.

There will be no further ethical issues due to the fact that all data are used will be voluntary provided by the data owner and data will only be measured in consent with the land owners.

Table 6 ETHICAL ISSUES TABLE

	Research on Human Embryo/ Foetus	YES	Page
*	Does the proposed research involve human Embryos?		
*	Does the proposed research involve human Foetal Tissues/ Cells?		
*	Does the proposed research involve human Embryonic Stem Cells (hESCs)?		
*	Does the proposed research on human Embryonic Stem Cells involve cells in culture?		
*	Does the proposed research on Human Embryonic Stem Cells involve the derivation of cells from Embryos?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	YES	

	Research on Humans	YES	Page
*	Does the proposed research involve children?		
*	Does the proposed research involve patients?		
*	Does the proposed research involve persons not able to give consent?		
*	Does the proposed research involve adult healthy volunteers?		
	Does the proposed research involve Human genetic material?		
	Does the proposed research involve Human biological samples?		
	Does the proposed research involve Human data collection?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	YES	

	Privacy	YES	Page
	Does the proposed research involve processing of genetic information or personal data (e.g. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?		
	Does the proposed research involve tracking the location or observation of people?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	YES	

	Research on Animals	YES	Page
	Does the proposed research involve research on animals?		
	Are those animals transgenic small laboratory animals?		
	Are those animals transgenic farm animals?		
*	Are those animals non-human primates?		
	Are those animals cloned farm animals?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	YES	

	Research Involving Developing Countries	YES	Page
	Does the proposed research involve the use of local resources (genetic, animal, plant, etc)?		
	Is the proposed research of benefit to local communities (e.g. capacity building, access to healthcare, education, etc)?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	YES	

	Dual Use	YES	Page
	Research having direct military use		
	Research having the potential for terrorist abuse I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	YES	

5 Consideration of gender aspects

ReCover project is not gender sensitive.

The project, the consortium and the participants' organisations are committed to the promotion of gender activities and equal opportunities between men and women.We recognise that in this project there is an unequal distribution of women and men. Most senior persons with expertise in the field of forestry are still men. In this project, there are five women involved. The deputy manager of the project, person in charge of the project at ALU-FR and two work package leaders are women. Our plan is to put effort in the recruitment of female candidates for open positions. We aim for a better gender balance during the project. All of the researchers in this consortium are committed to the equal participation of women in research and in technology. All members of the consortia have equal opportunities policies that comply fully with both their national and EU policies.

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Annex 1 List of products delivered by ReCover project

Product name	Product description	Point of Contact/ Service Provider	User	EO data available or planned	MMU	Resolution and accuracy	Coverage
Image mosaic map of year 1992-1994 1992-1994 (Mexico) 1990 (Brazil) 1990 (DRC)	Optical mosaic	VTT Norut	CONAFOR PMC INPE OSFAC	Landsat (AVHRR) ERS to augment cloudy areas	1 pixel	Original resolution of the imagery	Selected areas of Chiapas state in Mexico Tapajós, Pará State, BR Selected site (DRC)
Image mosaic map of year 2004-2011 2000, 2010 (Brazil) 2000, 2010 (DRC)	Optical mosaic	VTT Norut	CONAFOR PMC INPE OSFAC	Spot Landsat (Modis,AVHRR) Quickbird or equivalent Aster IRS Radarsat-2, Envisat- ASAR, ALOS-PALSAR, Terrasar-X ALOS-AVNIR-2, RapidEye	1 pixel	Original resolution of the imagery	Selected areas of Chiapas state in Mexico Tapajós, Pará State, BR Selected site, DRC
2007-2011 (Guyana) 2009-11 (Fiji)	Radar Mosaic	WU	GFC FFD	ALOS-PALSAR ENVISAT ASAR	1 pixel	Original resolution of the imagery	National coverage
2005-2010 (Brazil) 2000-2005-2010 (DRC)	Radar Mosaic	Norut Norut	INPE OSFAC	*ALOS-PALSAR* *ENVISAT ASAR & ERS-1&2* *Radarsat-2* *Terrasar-X,*	1 pixel	Original resolution of the imagery	Tapajós, Pará State, BR Selected site (DRC)
Forest/land cover map of year 1992-1994, 2004-2011 1990, 2000, 2010 (Brazil) 1990, 2000, 2010 (Africa) 2010 Fiji 2010 (Guyana)	Forest – non forest	VTT Norut WU	CONAFOR PMC INPE OSFAC GFC FFD	Landsat (Modis, AVHRR) ERS to augment cloudy areas Spot Quickbird or equivalent Aster IRS Radarsat-2, Envisat- ASAR ALOS-PALSAR, Terrasar-X ALOS-AVNIR-2, RapidEye	4-9 pixels	overall 80-90 % prod. acc 80-90% user acc 80-90 %	Selected areas of Chiapas state in Mexico Tapajós, Pará State, BR Selected site, DRC FRA2010, GEO) in Guyana National coverage for Fiji

Product name	**Product description**	**Point of Contact/ Service Provider**	**User**	**EO data available or planned**	**MMU**	**Resolution and accuracy**	**Coverage**
Forest biomass map of year 1992-1994, 2004-2011 2010 (Brazil) 2010 (DRC) 2010 Fiji 2010 (Guyana)		VTT Norut WU	CONAFOR PMC INPE OSFAC GFC FFD	Landsat (Modis, AVHRR) ERS to augment cloudy areas Spot Quickbird or equivalent Aster IRS Radarsat-2, *Envisat- ASAR,* ALOS-PALSAR, *Terrasar-X* ALOS-AVNIR-2, RapidEye	4-9 pixels	30-20 % mean stock (t/ha)	Selected areas of Chiapas state in Mexico Tapajós, Pará State, BR Selected site, DRC Guyana selected REDD site Fiji selected REDD site
Forest degradation map of year 1992-1994, 2004-2011 2009-11 Fiji 2009-11 (Guyana) 1990,2000,2010 (Brazil) 1990,2000,2010 (DRC)	Low vegetation cover, medium vegetation cover and high vegetation cover	VTT WU Norut	CONAFOR PMC GFC FFD INPE OSFAC	Landsat (Modis, AVHRR) ERS to augment cloudy areas Spot Quickbird or equivalent Aster IRS Radarsat-2, *Envisat- ASAR* ALOS-PALSAR, *Terrasar-X* ALOS-AVNIR-2, RapidEye	4-9 pixels	overall 70-80 % prod. acc. 70-80 % user acc 70-80 %	Selected areas of Chiapas state in Mexico Guyana selected REDD site Fiji selected REDD site Tapajós, Pará State, BR Selected site, DRC
Forest area change map 1992-1994, 2004 – 2011 1990-2000, 2000-2010 (Brazil) 1990-2000, 2000-2010 (DRC)		VTT Norut	CONAFOR PMC INPE OSFAC	Landsat (Modis, AVHRR) ERS to augment cloudy areas Spot Quickbird or equivalent Aster IRS Radarsat-2, *Envisat- ASAR* ALOS-PALSAR, *Terrasar-X* ALOS-AVNIR-2, RapidEye	4-9 pixels	overall 70-80 % prod. acc. 70-80 % user acc 70-80 %	Selected areas of Chiapas state in Mexico Tapajós, Pará State, BR Selected site, DRC

Product name	Product description	Point of Contact/ Service Provider	User	EO data available or planned	MMU	Resolution and accuracy	Coverage
Accuracy assessment dataset for IPCC activity data verification 2010	Reference data set and statistics for area change accuracy assessment	WU	FFD	Spot Quickbird or equivalent Aster TerraSAR	1 pixel	overall 90 %	National coverage for Fiji (sampling)
Forest biomass change map 1992-1994, 2004 – 2011		VTT	CONAFOR PMC	Landsat (Modis, AVHRR) ERS to augment cloudy areas Spot Quickbird or equivalent Aster IRS Radarsat-2 ALOS-PALSAR ALOS-AVNIR-2, RapidEye	4-9 pixels	N.A.	Selected areas of Chiapas state in Mexico
Calibration/validation of remote sensing estimations (carbon) using sampling sites (all IPCC pools) 1992-1994, 2004-2011		VTT	PMC	Landsat (Modis, AVHRR) ERS to augment cloudy areas Spot Quickbird or equivalent Aster IRS Radarsat-2 ALOS-PALSAR ALOS-AVNIR-2, RapidEye	4-9 pixels	± 1.5 standard deviation	Selected areas of Chiapas state in Mexico
Assimilation of remote sensing carbon estimation in Mexico carbon budget of GHG emissions 1992-1994, 2004-2011		VTT	PMC	N.A		± 1.5 standard deviation	Selected areas of Chiapas state in Mexico

Annex 2 List of ancillary data needed/available.

Site	Product name	Description of the in situ data available
Mexico	Image mosaic map of year 1992-1994	1992-1994: 48 000 sampling sites of size 1000 m^2
Mexico	Image mosaic map of year 2004-2011	2004-2007:100 000 sampling sites of size 400 m^2
Mexico	Forest/land cover map of year 1992-1994, 2004-2011	1992-1994: 48 000 sampling sites of size 1000 m^2 2004-2007:100 000 sampling sites of size 400 m^2
Mexico	Forest biomass map of year 1992-1994, 2004-2011	1992-1994: 48 000 sampling sites of size 1000 m^2 2004-2007:100 000 sampling sites of size 400 m^2
Mexico	Forest degradation map of year 1992-1994, 2004-2011	1992-1994: 48 000 sampling sites of size 1000 m^2 2004-2007:100 000 sampling sites of size 400 m^2
Mexico	Forest area change map 1992-1994, 2004 – 2011	1992-1994: 48 000 sampling sites of size 1000 m^2 2004-2007:100 000 sampling sites of size 400 m^2 2009 - : 20 000 resampling sites of the sites sampled in 2004-2007
Mexico	Forest biomass change map 1992-1994, 2004 – 2011	1992-1994: 48 000 sampling sites of size 1000 m^2 2004-2007:100 000 sampling sites of size 400 m^2 2009 - : 20 000 resampling sites of the sites sampled in 2004-2007
Mexico	Calibration/validation of remote sensing estimations (carbon) using sampling sites (all IPCC pools) 1992-1994, 2004-2011	1992-1994: 48 000 sampling sites of size 1000 m^2 2004-2007:100 000 sampling sites of size 400 m^2 2009 - : 20 000 resampling sites of the sites sampled in 2004-2007
Mexico		SRTM DEM
Mexico		ASTER DEM
Mexico		Lidar data
Guyana	Image mosaic map	SRTM DEM, ASTER DEM, existing forest map
Guyana	Forest maps and biomass map (sub-national)	2009-11: ca. 500 new sampling sites of size 400 m^2
Fiji	Image mosaic and forest map	2006: national inventory sites
Fiji	Image mosaic map	SRTM DEM, ASTER DEM, existing forest map 2002
Fiji	Forest maps and biomass map (sub-national)	2009-11: ca. 500 new sampling sites of size 400 m^2

Site	Product name	Description of the in situ data available
Brazil (Tapajós)	Image mosaic maps (1990,2000,2005,2010)	SRTM DEM, CBERS data Since 1988: Landsat TM / ETM+ Since 1988: Deforestation maps from INPE (PRODEX, DETER), Since 1990: scattered SAR data (JERS, Radarsat, ERS, Envisat), Since 2000: Terra/MODIS images and products archived 2001: Hyperespectral data from EO1 Hyperion sensor. 1999/2000: Digital videography acquired Since 1988: many ground truth compains about land-use, cover, vegetation biophysical data
Brazil (Tapajós)	Forest/land cover map of year 1990, 2000, 2010	SRTM DEM, CBERS data Since 1988: Landsat TM / ETM+ Since 1988: Deforestation maps from INPE (PRODEX, DETER), Since 1990: scattered SAR data (JERS, Radarsat, ERS, Envisat), Since 2000: Terra/MODIS images and products archived 2001: Hyperespectral data from EO1 Hyperion sensor. 1999/2000: Digital videography acquired Since 1988: many ground truth compains about land-use, cover, vegetation biophysical data
Brazil (Tapajós)	Forest biomass map of year 2010	SRTM DEM, CBERS data Since 1988: Landsat TM / ETM+ Since 1988: Deforestation maps from INPE (PRODEX, DETER), Since 1990: scattered SAR data (JERS, Radarsat, ERS, Envisat), Since 2000: Terra/MODIS images and products archived 2001: Hyperespectral data from EO1 Hyperion sensor. 1999/2000: Digital videography acquired Since 1988: many ground truth compains about land-use, cover, vegetation biophysical data
Brazil (Tapajós)	Forest degradation map of year 1990, 2000, 2010	SRTM DEM, CBERS data Since 1988: Landsat TM / ETM+ Since 1988: Deforestation maps from INPE (PRODEX, DETER), Since 1990: scattered SAR data (JERS, Radarsat, ERS, Envisat), Since 2000: Terra/MODIS images and products archived 2001: Hyperespectral data from EO1 Hyperion sensor. 1999/2000: Digital videography acquired Since 1988: many ground truth compains about land-use, cover, vegetation biophysical data

Site	Product name	Description of the in situ data available
DRC	All products	OSFAC: At this moment we haven't collected field data, but they are going to be needed in the future, such as ground truth in order to validate the land cover classification (GEO project).In addition we will plan to get other data such as biomass measurements for the carbon stock estimation (CBFF project).The data will be collected for CBFF project purpose so as to estimate biomass and carbon stock. 1) above-ground biomass 2) below-ground biomass 3) litter (dead organic matter) 4) dead wood (dead organic matter) 5) soil organic matter (Mineral and organic) GEO project: Free access to satellite data from major international space agencies, technical and financial assistance in the collection of airborne Lidar, ALOS PALSAR and in situ data, assistance and international collaboration in the processing of data, capacity building programmes and other donor assistance to meet international reporting requirements. There is much socio-economic information collected in the study area that our partner here CARPE (Central African Regional Project for Environment) may put at our disposal. Maps and statistics on forest cover and forest change (degradation, deforestation) in all Congo Basin are available.

Annex 3 Summary of requested EO data

Site	Product name	EO Sensor	Type of EO product	Processing level	Coverage [km^2]	Date	Amount of scenes	Costs [€]
Mexico	All products of this site	ERS	PRI image	ASAR processor Level 1	110x110 km^2	1992 - 1994	30	Through data access grant
Mexico	All products of this site	ASAR	IMP IS4	Level 1	100x100 km^2	2004-2011	40	Through data access grant
Mexico	All products of this site	Quickbird or equivalent	Multispectral Pan-sharpened	orthorectified	10x10 km^2	2004 - 2011	25-30	Through data access grant
Mexico	All products of this site	ALOS AVNIR-2, RapidEye	Multispectral	orthorectified	70x70 km^2	2007-2011	10-20	Through data access grant
Guyana	National	ENVISAT ASAR	PRI image	ASAR processor Level 1	110x110 km^2	2007-11	50-60	Through data access grant or GEO FCT task
Guyana	National	ALOS PALSAR	FBD image	CEOS Level 1.1	60x60 km^2	2007-11	80-100	Through data access grant or GEO FCT task or Kyoto and Carbon (tbc)
Guyana	All products of this site	TERRASAR-X	Spotlight mode	SCC	10x10 km^2	2007-11	20-30	Through data access grant or GEO FCT task (tbc)
Guyana	All products of this site	Quickbird or equivalent	Multispectral Pan-sharpened	orthorectified	10x10 km^2	2004 - 2011	20-25	Through data access grant
Guyana	All products of this site	SPOT-5	Multispectral Pan-sharpened	orthorectified	60x60 km^2	2009 - 2011	15-20	Through data access grant
Guyana	All products of this site	ALOS AVNIR-2, RapidEye	Multispectral	orthorectified	70x70 km^2	2007-2011	10-20	Through data access grant
Fiji	National	ENVISAT ASAR	PRI image	ASAR processor Level 1	110x110 km^2	2007-11	50-60	Through data access grant
Fiji	National	ALOS PALSAR	FBD image	CEOS Level 1.1	60x60 km^2	2007-11	80-100	Through data access grant
Fiji	All products of this site	TERRASAR-X	Spotlight mode	SCC	10x10 km^2	2007-11	20-30	Through data access grant
Fiji	All products of this site	Quickbird or equivalent	Multispectral Pan-sharpened	orthorectified	10x10 km^2	2004 - 2011	20-25	Through data access grant
Fiji	National	SPOT-5	Multispectral Pan-sharpened	orthorectified	60x60 km^2	2009 - 2011	20-25	Through data access grant
Fiji	All products of this site	ALOS AVNIR-2, RapidEye	Multispectral	orthorectified	70x70 km^2	2007-2011	10-20	Through data access grant
DRC	All products of these sites	ERS	PRI image	ASAR processor Level 1	110x110 km^2	2000	10-20	Through data access grant

Site	Product name	EO Sensor	Type of EO product	Processing level	Coverage [km^2]	Date	Amount of scenes	Costs [€]
DRC	All products of these sites	ENVISAT ASAR	Alternate polarization, image mode. All archived modes (wide-swath, image, alternate pol.)	ASAR processor Level 1	110x110 km^2	2003-11	30-40	Through data access grant or GEO FCT task
DRC	All products of these sites	Radarsat-2	Fine /standard SLC dual-pol	CEOS Level 1.1	50x50 km^2 100x100 km^2	2007-11	20-30	Through data access grant or GEO FCT task or Kyoto and Carbon (tbc)
DRC	All products of these sites	ALOS PALSAR	FBD image	CEOS Level 1.1	60x60 km^2	2007-11	80-100	Through data access grant or GEO FCT task or Kyoto and Carbon (tbc)
DRC	All products of these sites	TERRASAR-X	Spotlight mode	SCC	10x10 km^2	2007-11	20-30	Through data access grant or GEO FCT task (tbc)
DRC	All products of these sites	Quickbird or equivalent	Multispectral Pan-sharpened	orthorectified	10x10 km^2	2004 - 2011	20-25	Through data access grant
DRC	All products of these sites	SPOT-5	Multispectral Pan-sharpened	orthorectified	60x60 km^2	2009 - 2011	15-20	Through data access grant
DRC	All products of this site	ALOS AVNIR-2, RapidEye	Multispectral	orthorectified	70x70 km^2	2007-2011	10-20	Through data access grant
Brazil (Tapajós, Boca do Acre)	All products of these sites	ERS	PRI image	ASAR processor Level 1	110x110 km^2	1992-2003	30	Through data access grant
Brazil (Tapajós, Boca do Acre)	All products of these sites	ENVISAT ASAR	Alternate polarization, image mode. All archived modes (wide-swath, image, alternate pol.)	ASAR processor Level 1	110x110 km^2	2003-11	30-40	Through data access grant or GEO FCT task
Brazil (Tapajós)	All products of these sites	Radarsat-2	Fine /standard SLC dual-pol	CEOS Level 1.1	50x50 km^2 100x100 km^2	2007-11	20-30	Through data access grant or GEO FCT task or Kyoto and Carbon (tbc)
Brazil (Tapajós, Boca do Acre)	All products of these sites	ALOS PALSAR	FBD image	CEOS Level 1.1	60x60 km^2	2007-11	80-100	Through data access grant or GEO FCT task or Kyoto and Carbon (tbc)

Site	Product name	EO Sensor	Type of EO product	Processing level	Coverage [km^2]	Date	Amount of scenes	Costs [€]
Brazil (Tapajós, Boca do Acre)	All products of these sites	TERRASAR-X	Spotlight mode	SCC	10x10 km^2	2007-11	20-30	Through data access grant or GEO FCT task (tbc)
Brazil (Tapajós, Boca do Acre)	All products of these sites	Quickbird or equivalent	Multispectral Pan-sharpened	orthorectified	10x10 km^2	2004 - 2011	20-25	Through data access grant
Brazil (Tapajós, Boca do Acre)	All products of these sites	SPOT-5	Multispectral Pan-sharpened	orthorectified	60x60 km^2	2009 - 2011	15-20	Through data access grant
Brazil (Tapajós, Boca do Acre)	All products of this site	ALOS AVNIR-2, RapidEye	Multispectral	orthorectified	70x70 km^2	2007-2011	10-20	Through data access grant

Annex 4 Service Requirements

Mexico

Type:	FP7/GSE	**Domain:**	Land	**Project Name:**	ReCover
Application:	Reducing Emissions from Deforestation and forest Degradation (REDD)				
Description:	FP7 Space call 2010: SPA.2010.1.1-04 Stimulating the development of GMES services in specific areas				
Class:	Mandatory	**Start Delivery:**	2010		

Area of interest:	Mexico: Chiapas state		
Estimated Surface:	Maximum 50 000 km^2: VHR 25-30 images, ERS 30 images and ASAR 40 images, Alos AVNIR-2 or RapidEye 10-20 images		
Geo-location accuracy:	10m (+/- 5m)	**Map Scale:**	N/A

Satellite tasking:	Predefined	**Delivery:**	Normal Arch normal
Mapping Frequency:	Yearly		
Delivery Mechanism:	On-line availability at GSCDA recipient		
Physical destination of Data:	VTT, Espoo, Finland		

Optical Bands:	Multispectral Pan	**Optical Resolution:**	0.5 - 0.6 m (VHR) 10 m (AVNIR or RapidEye)
Optical Processing Level:	Level 1B	**Optical Ortho.:**	yes
Comments	N/A		

Radar bands	C	**Radar Resolution:**	HR
Radar Acquisition:	Stripmap	**Radar Polarisation:**	VV (ERS), HH (ASAR)
Radar Processing Level:	Level 1	**Radar Product:**	Ground range detected multi-look
Comments	ERS and ASAR data		
Optical-Radar composite information:	Radar and AVNIR or RapidEye wall-to-wall coverage, Quickbird or equivalent sample		
Any other sensor:	N/A		

	2008	**2009**	**2010**	**2011**
Optical acquisition plan:	N/A	N/A	Archived data needs to be delivered	If needed, new acquisitions need to be delivered
Optical Archive:	Quickbird (or equivalent) data from 2004-2010, about 30 images Alos AVNIR-2 or RapidEye 10-20 images			
Comments:	N/A			

	2008	**2009**	**2010**	**2011**
Radar Acquisition Plan	N/A	N/A	Archived data needs to be delivered	If needed, new acquisitions need to be delivered
Radar Archive:	ERS PRI images from 1992-1994, about 30 images			

	ASAR about 40 images
Comments:	N/A
Constraints:	
Other information:	N/A

Guyana

Type:	FP7/GSE	**Domain:**	Land	**Project Name:**	ReCover
Application:	Reducing Emissions from Deforestation and forest Degradation (REDD)				
Description:	FP7 Space call 2010: SPA.2010.1.1-04 Stimulating the development of GMES services in specific areas				
Class:	Mandatory	**Start Delivery:**	2010		

Area of interest:	Guyana national coverage (image data) and for selected test sites (high resolution)		
Estimated Surface:	National: 214.970 km^2; sub-national sites Maximum 30 000 km^2: VHR 20-25 images, Alos AVNIR-2 or RapidEye 10-20 images		
Geo-location accuracy:	10m (+/- 5m)	**Map Scale:**	N/A
Satellite tasking:	Predefined	**Delivery:**	Normal Arch normal
Mapping Frequency:	Yearly		
Delivery Mechanism:	On-line availability at GSCDA recipient		
Physical destination of Data:	WU, Wageningen, Netherlands		
Optical Bands:	Multispectral Pan	**Optical Resolution:**	0.5 - 0.6 m 10 m (AVNIR or RapidEye)
Optical Processing Level:	Level 1B	**Optical Ortho.:**	yes
Comments	N/A		
Radar bands	X, C, L	**Radar Resolution:**	HR
Radar Acquisition:	Stripmap, FBD, Spotlight	**Radar Polarisation:**	VV, HH, HV
Radar Processing Level:	Level 1(.1)	**Radar Product:**	Ground range
Comments	ASAR data (national), ALOS-PALSAR (national), TERRASAR-X (selected test sites, Maximum 20 000 km^2)		
Optical-Radar composite information:	Radar (ALOS, ASAR) annual wall-to-wall coverage, SPOT-5 Quickbird AVNIR or RapidEye and Terrasar or equivalent as sample in selected sites		
Any other sensor:	N/A		

	2008	**2009**	**2010**	**2011**
Optical acquisition plan:	N/A	N/A	Archived data needs to be delivered	If needed, new acquisitions need to be delivered
Optical Archive:	Quickbird (or equivalent) data from 2009-2011, about 20 images + SPOT-5 images max. 20 Alos AVNIR-2 or RapidEye 10-20 images			
Comments:	N/A			

	2008	**2009**	**2010**	**2011**
Radar Acquisition Plan	N/A	N/A	Archived data needs to be delivered for ALOS and ASAR	New acquisitions need to be delivered to ensure annual

				coverage
Radar Archive:	ALOS PALSAR FBD, ASAR PRI/STRIPMAP, TERRASAR Spotlight			
Comments:	N/A			

Constraints:	Combination of optical and radar data essential for test sites, national coverage by Radar data sufficient
Other information:	Some data already acquired as part of GEO Forest Carbon Tracking task but need to be made available for the project

Fiji

Type:	FP7/GSE	**Domain:**	Land	**Project Name:**	ReCover
Application:	Reducing Emissions from Deforestation and forest Degradation (REDD)				
Description:	FP7 Space call 2010: SPA.2010.1.1-04 Stimulating the development of GMES services in specific areas				
Class:	Mandatory	**Start Delivery:**	2010		

Area of interest:	Fiji national coverage (image data) and for selected test sites (high resolution)		
Estimated Surface:	Maximum 15 000 km^2: VHR 20-25 images (many small islands and for accuracy assessment sampling), Alos AVNIR-2 or RapidEye 10-20 images		
Geo-location accuracy:	10m (+/- 5m)	**Map Scale:**	N/A
Satellite tasking:	Predefined	**Delivery:**	Normal Arch normal
Mapping Frequency:	Yearly		
Delivery Mechanism:	On-line availability at GSCDA recipient		
Physical destination of Data:	WU, Wageningen, Netherlands		
Optical Bands:	Multispectral Pan	**Optical Resolution:**	0.5 - 0.6 m 10 m (AVNIR or RapidEye)
Optical Processing Level:	Level 1B	**Optical Ortho.:**	yes
Comments	N/A		
Radar bands	X, C, L	**Radar Resolution:**	HR
Radar Acquisition:	Stripmap, FBD, Spotlight	**Radar Polarisation:**	VV, HH, HV
Radar Processing Level:	Level 1(.1)	**Radar Product:**	Ground range
Comments	ASAR data (national), ALOS-PALSAR (national), TERRASAR-X (selected test sites, Maximum 15 000 km^2)		
Optical-Radar composite information:	Radar (ALOS, ASAR) annual wall-to-wall coverage, Quickbird, AVNIR or RapidEye and Terrasar or equivalent as sample in selected sites		
Any other sensor:	N/A		

	2008	2009	2010	2011
Optical acquisition plan:	N/A	N/A	Archived data needs to be delivered	If needed, new acquisitions need to be delivered
Optical Archive:	Quickbird (or equivalent) data from 2009-2011, about 20-25 images + SPOT 5 national coverage (20-25 images) Alos AVNIR-2 or RapidEye 10-20 images			
Comments:	Fiji consists of many small islands			

	2008	2009	2010	2011
Radar Acquisition Plan	N/A	N/A	Archived data needs to be delivered for	New acquisitions need to be

			ALOS and ASAR	delivered to ensure annual coverage
Radar Archive:	ALOS PALSAR FBD, ASAR PRI/STRIPMAP, TERRASAR Spotlight			
Comments:	N/A			
Constraints:	Combination of optical and radar data essential for test sites, national coverage by Radar data sufficient			
Other information:				

Brazil

Type:	FP7/GSE	**Domain:**	Land	**Project Name:**	ReCover
Application:	Reducing Emissions from Deforestation and forest Degradation (REDD)				
Description:	FP7 Space call 2010: SPA.2010.1.1-04 Stimulating the development of GMES services in specific areas				
Class:	Mandatory	**Start Delivery:**	2010		

Area of interest:	Brazil: Tapajós, Pará State Brazil: Boca do Acre, Amazonas State		
Estimated Surface:	2x 40.000km^2 VHR 20-25 images, Alos AVNIR-2 or RapidEye 10-20 images		
Geo-location accuracy:	10m (+/- 5m)	**Map Scale:**	N/A
Satellite tasking:	Predefined	**Delivery:**	Normal Arch normal
Mapping Frequency:	Monthly/yearly		
Delivery Mechanism:	On-line availability at GSCDA recipient		
Physical destination of Data:	Norut, Tromsø, Norway		
Optical Bands:	Multispectral Pan	**Optical Resolution:**	0.5 - 0.6 m 10 m (AVNIR or RapidEye)
Optical Processing Level:	Level 1B	**Optical Ortho.:**	yes
Comments	N/A		
Radar bands	X, C, L	**Radar Resolution:**	MR, HR
Radar Acquisition:	Stripmap, FBD, Spotlight, Envisat ASAR (AP, altermatively image mode)	**Radar Polarisation:**	VV, HH, HV
Radar Processing Level:	Level 1(.1)	**Radar Product:**	Ground range
Comments	Envisat ASAR data (monthly coverage over the two sites), ALOS-PALSAR (yearly coverage), Tandem-X (yearly coverage for height estimation)		
Optical-Radar composite information:	Radar (ALOS, ASAR, Radarsat) and AVNIR or RapidEye annual wall-to-wall coverage, SPOT-5 Quickbird and Terrasar-X or equivalent as sample in selected sites		
Any other sensor:	N/A		

	2008	**2009**	**2010**	**2011**
Optical acquisition plan:	N/A	N/A	Archived data needs to be delivered	If needed, new acquisitions need to be delivered
Optical Archive:	Quickbird (or equivalent) data from 2009-2011, about 20 images + SPOT-5 images max. 20 Alos AVNIR-2 or RapidEye 10-20 images			
Comments:	N/A			

	2008	2009	2010	2011
Radar Acquisition Plan	N/A	N/A	Archived data needs to be delivered for ALOS and ASAR	New acquisitions need to be delivered to ensure annual coverage
Radar Archive:	ALOS PALSAR FBD, ERS, ASAR PRI/STRIPMAP, TERRASAR Spotlight			
Comments:	N/A			
Constraints:	Combination of optical and radar data essential for test sites			
Other information:	Some data already acquired as part of GEO Forest Carbon Tracking task but need to be made available for the project			

DRC

Type:	FP7/GSE	**Domain:**	Land	**Project Name:**	ReCover
Application:	Reducing Emissions from Deforestation and forest Degradation (REDD)				
Description:	FP7 Space call 2010: SPA.2010.1.1-04 Stimulating the development of GMES services in specific areas				
Class:	Mandatory		**Start Delivery:**	2010	

Area of interest:	Democratic Republic Congo, ND test site		
Estimated Surface:	~40.000km^2 VHR 20-25 images, Alos AVNIR-2 or RapidEye 10-20 images		
Geo-location accuracy:	10m (+/- 5m)	**Map Scale:**	N/A
Satellite tasking:	Predefined	**Delivery:**	Normal Arch normal
Mapping Frequency:	Monthly/yearly		
Delivery Mechanism:	On-line availability at GSCDA recipient		
Physical destination of Data:	Norut, Tromsø, Norway		
Optical Bands:	Multispectral Pan	**Optical Resolution:**	0.5 - 0.6 m 10 m (AVNIR or RapidEye)
Optical Processing Level:	Level 1B	**Optical Ortho.:**	yes
Comments	N/A		
Radar bands	X, C, L	**Radar Resolution:**	MR, HR
Radar Acquisition:	Stripmap, FBD, Spotlight, Envisat ASAR (AP, altermatively image mode)	**Radar Polarisation:**	VV, HH, HV
Radar Processing Level:	Level 1(.1)	**Radar Product:**	Ground range
Comments	Envisat ASAR data (monthly coverage), ALOS-PALSAR (yearly coverage), Tandem-X (yearly coverage for height estimation)		
Optical-Radar composite information:	Radar (ALOS, ASAR, Radarsat) and AVNIR or RapidEye annual wall-to-wall coverage, SPOT-5 Quickbird and Terrasar-X or equivalent as sample in selected sites		
Any other sensor:	N/A		

	2008	**2009**	**2010**	**2011**
Optical acquisition plan:	N/A	N/A	Archived data needs to be delivered	If needed, new acquisitions need to be delivered
Optical Archive:	Quickbird (or equivalent) data from 2009-2011, about 20 images + SPOT-5 images max. 20 Alos AVNIR-2 or RapidEye 10-20 images			
Comments:	N/A			

Radar Acquisition Plan	**2008**	**2009**	**2010**	**2011**

	N/A	N/A	Archived data needs to be delivered for ALOS and ASAR	New acquisitions need to be delivered to ensure annual coverage
Radar Archive:	ALOS PALSAR FBD, ASAR PRI/STRIPMAP, TERRASAR Spotlight			
Comments:	N/A			

Constraints:	Combination of optical and radar data essential for test sites
Other information:	Some data already acquired as part of GEO Forest Carbon Tracking task but need to be made available for the project

Annex 5 User description

Mexican Users Description:

CONAFOR (National Forestry Commission) is in charge of the forestry sector in Mexico and is the leading governmental institution (POC) in the REDD implementation strategy. The Forestry Inventories and Geomatics unit is the responsible for the NFI in the country and the reporting and monitoring of forestry activities (LUC).

PMC (Mexican Carbon Program) is the responsible for the science national strategy regarding C dynamics and it is the science counterpart of Mexico in the CarboNA (North American Carbon Program). PMC is leading the MRV of the REDD implementation strategy in Mexico and the GHG inventories for UNFCCC of Mexico.

INPE – The Brazilian National Institute for Space Research

INPE has a program for Brazilian Amazonian Forest monitoring that includes 4 operational and complimentary systems : PRODES (annual estimates of gross deforestation since 1988), DETER (near real-time detection of deforestation in coarser spatial resolution data since 2003), DEGRAD (mapping of degraded forest since 2008) and QUEIMADAS (mapping of active fire since 1985). Those systems provide data that helps Brazilian Government to plan forest conservation actions and reduce forest conversion. INPE's mission is to produce science and technology for space and environmental subjects, as well as to provide related products and services to the Brazilian. REDD mechanisms and policy actions are defined by the Ministry of Environment through its agencies IBAMA and Forestry Service.
INPE will use the data, products and results produced by this joint project for improving techniques and accuracy of the data provided by its forest monitoring systems. Also, results can supply a baseline for a long duration temporal analysis of many different remote sensing and field data.

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Guyana Forestry Commission (GFC):

The GFC is the national agency responsible for advising the subject Minister on issues relating to forest policy, forestry laws and regulations. The Commission is also responsible for the administration and management of all State Forest land and the conduct all national forest monitoring activities. The work of the Commission is guided by a Draft National Forest Plan that has been developed to address the forest policy. The Commission develops and monitors standards for forest sector operations, develops and implements forest protection and conservation strategies, oversees forest research and provides support and guidance to forest education and training. The GFC is the key coordinating agency for REDD Monitoring, Reporting and Verification including related remote sensing activities. GFC is coordinating REDD activities and leads consultation and networking among relevant agencies and stakeholders on the national and international level. Work includes the ambition to work with ongoing international efforts of the Group on Earth Observations (GEO) Forest Carbon Tracking task, where Guyana is a key demonstration country, and the remote sensing survey of FAO's Forest Resources Assessment 2010 and related national reporting activities.

Key links:

http://www.forestry.gov.gy/

Terms of Reference for REDD monitoring system development:
http://www.forestry.gov.gy/Downloads/Terms_of_%20Reference_for_Guyana%27s_MRVS_Draft.pdf

Fiji Forestry Department:

The Fiji Forestry Department as part of Ministry of Fisheries and Forest is a newly established Ministry of the Government. It was established with the aim to enhance sectors visibility and streamline decision-making so that it is more responsive and proactive in facilitating the sustainable development of the forest sector. All forest related national monitoring is done by the Forestry department. NFI's for forest land conducted for 1991 and 2006. A remote sensing based forest cover map exists for the year 2002. Fiji's forestry department prepares the country reports for FAO's global forest resources assessment. The Forestry Department is concerned with the expansion of agriculture and infrastructure that are not systematically measured with existing inventory methods and constitutes an existing data gap. Thus, the amount of natural forest has consistently declined of the recent years with the actual area being unknown at this point. Thus, the Forestry Department is interested in strengthening its capacities, and institutional and infrastructure development. Fiji Forestry Department is the leading national agency for REDD monitoring and has already embarked on implementing a roadmap for establishing national capacities and evolve REDD readiness for participating in the post-Kyoto climate agreement implementation:
http://www.spc.int/lrd/Climate_change_resources.htm

OSFAC - Observatoire Satellital des Forêts d'Afrique Centrale

As the Central Africa regional GOFC-GOLD network, OSFAC works to improve the quality and availability of satellite observations of forest and land cover in the Congo Basin and to produce useful and timely information products for a wide variety of users. It is a legally recognized NGO in the Democratic Republic of Congo that operates with a regional mandate to promote the use of satellite data and products for the management of natural resources and sustainable development.
Its partners are UM, SDSU, Université Catholique de Louvain, EU Joint Research Center, NASA, African Wildlife Foundation, CARPE, OFAC, Ecole Régionale post-universitaire d'Aménagement et de Gestion Integrés des Forêts, Université de Kinshasa, USAID, Wildlife Conservation Society, World Resources Institute and World Wide Fund.

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Annex 6 Subcontract: 3D tomography of space-borne SAR data for vegetation analysis in forest environment

Goals and Work Plan

The general goal of the project is the retrieval of vegetation parameters, such as height, density, and distribution by utilizing tomographic methods. The project will contribute the essential ingredients to this vision. The work plan consists of following work packages:

Theory:

- Existing tomographic algorithms will be analyzed regarding their underlying concepts and algorithms.
- Based on this analysis, a theoretical framework will be designed to enable the 3D imaging of vegetation using available space-borne SAR data, such as ALOS-PALSAR, TerraSAR-X or RADARSAR-2 data.
- Model-based parameters estimation techniques will be adapted in order to allow the determination of vegetation parameters from tomographic SAR data.

Development of methods:

- Algorithms for 3D tomographic SAR imaging which allow to identifying and resolving multiple (i.e. overlaying) scatterers from sparsely and irregularly sampled apertures of different satellite orbits will be implemented and tested.
- Methods for retrieving vegetation parameters from tomographic SAR data will be implemented and tested.
- Data fusion will be applied to merge interferometric motion measurements from different incidence angles and from ascending and descending orbits for an optimum registration. Ascending and descending acquisitions show opposite parts of the objects and are required for a complete 3D description.

Performance characterization:

For the investigations data from the ALOS (Advanced Land Observing Satellite) PALSAR sensor will be used. Depending on the data availability, various test sites can be select. For a specific forest test site located in Alaska, USA, an ALOS image stack has already been acquired. Additional ground truth data provided by colleagues from University of Alaska Fairbanks for evaluation will be available, too.

- Algorithm tests:
  The tomographic algorithms developed in the previous steps are applied and tuned to the real data. To thoroughly analyze the applicability of these algorithms, both man-made objects and forested areas should be contained in the scene. Results that are similar to pre-processed PSI stacks should be achieved at rigid man-made objects. For forested areas, on the other hand, the 3D distribution of volume scattering should be gained. In order to quantify the performance of SAR tomography, the 3D coordinates of single and multiple scatterers are compared to a digital elevation model acquired by a full waveform laser scanner.
- Algorithm evaluation:
  The algorithms for estimation of vegetation parameters are evaluated by verifying their results based on ground-truth data.

Budget:

To accomplish the above work plan a total financial budget of **25.000€** (5000€ budgeted, rest from other sources) is estimated. Data, infrastructure and soft- and hardware will be provided by the Institute of Photogrammetry and Remote Sensing.

Expertise:

Research on SAR remote sensing has been established at the Institute of Photogrammetry and Remote Sensing (IPF) already in the 1990ies, e.g. Sties [1998a; 1998b] and intensified with the appointment of Prof. Hinz as head of the institute in 2008 and the establishment of a joint "Active Sensing Group" (Dr. Jutzi, Dr. Westerhaus and 3 PhD students) in 2009. With this, long-time expertise on numerous scientific issues of SAR data analysis is brought into the project:

i) The development of advanced, high-precision methods for InSAR, [Thiele et al., 2007a; Thiele et al., 2007b; Thiele et al., 2009] and PSI with special focus on the TerraSAR-X mission [Gernhardt et al., 2007; Gernhardt & Hinz, 2008; Bamler et al., 2008];
ii) the extension of multi-baseline SAR Interferometry to SAR Tomography including comparison of simulated and real tomographic data [Auer et al., 2008; Auer et al., 2009];
iii) a 4D geometrical fusion scheme of multi-temporal and multi-aspect InSAR data [Cong et al., 2008];
iv) SAR signal processing for the estimation of moving objects [Hinz et al., 2007; Hinz et al., 2008; Hinz et al., 2009]; and
v) the development of a new SAR signal simulator for high-resolution 3D objects [Auer et al., 2010].

Annex 7 Software available in the consortium

Name	Description	Type	Possession
Probability*	Estimation of variables as continuous values from satellite data (category and continuous type)	In-house	VTT
AutoChange*	Change classification from satellite data	In-house	VTT
Envimon*	Pre-processing (geo-coding & atmospheric correction)	In-house	VTT
Pyramidas*	Image segmentation for object-based image analysis	In-house	VTT
SAR ortho-rectification and radiometric correction*	For all space-borne SAR	In-house	VTT
SAR mosaic compilation*	For all space-borne SAR	In-house	VTT
ERMapper	General remote sensing software	COTS	VTT, ALU-FR
ArcGIS	GIS software	COTS	VTT, WU, Arbonaut, ALU-FR, GMV
IDRISI	General remote sensing software	COTS	VTT, ECOSUR, ALU-FR
PolSARPro	Specific Radar software	COTS	VTT, ALU-FRs
Visual Studio	Software development software	COTS	VTT. ALU-FR
GRASS	GIS software	OpenSource	VTT, ALU-FR
ERDAS Imagine	Image processing	COTS	WU, ALU-FR
SARVISION SAR processor	SAR processing tool		In house/ Sarvision
Ecognition	Object-oriented image analysis tool		WU
ArboLidar	Forest estimation from LiDAR	In-house	Arbonaut
TerraScan	Lidar processing	COTS	Arbonaut
SPRING*	General remote sensing and GIS software available for download (http://www.dpi.inpe.br/spring/english/download.php).		INPE
PostgreSQL	DBMS	OpenSource	ALU-FR
ENVI IDL	General remote sensing software	COTS	ALU-FR, Norut, GMV
eCognition	General remote sensing software	COTS	ALU-FR
HALCON	General remote sensing software	COTS	ALU-FR
TreesVis	Specific Lidar software	In-house	ALU-FR
Stereo Analyst	Photogrammetric software	COTS	ALU-FR
ORIMA	Bundle block adjustment software	COTS	ALU-FR
OpenCV	Computer Vision Library	OpenSource	ALU-FR
Open MP	Multiprocessor System Software	OpenSource	ALU-FR
GDAL	Software development software	OpenSource	ALU-FR
TNT JAMA/C++	Software development software	OpenSource	ALU-FR
MatLab	Software development software	COTS	VTT,

			ALU-FR
EnviSnow operational processing line	ENVI/IDL based framework for operational SAR processing incl. pre-processing and geo-coding and several algorithm	In-house	Norut
Liferay	Application server provider for the implementation of the portal	Open source	GMV
MapServer	Platform for publishing spatial data and interactive mapping applications to the web	Open source	GMV
OpenLayer	JavaScript library for displaying map data,	Open source	GMV

*Available to ReCover project consortium

Annex 8 Service Level Agreements

SERVICE LEVEL AGREEMENT RELATED TO THE RE-COVER PROJECT

First project year

This agreement is concluded between VTT Technical Research Centre of Finland, Finland on behalf of the Re-Cover project consortium, hereafter referred to as the Service Provider, and Comision Nacional Forestal (CONAFOR) (Forestry Inventory and Geomatics Department), hereafter referred to as the User for the duration of three years with annual service revision and starting from the project kick-off date (to be defined in the approved project). The project lifecycle will be three years.

The agreement will be applicable only if the project proposal results in a grant agreement with the EC. In case of conflict between this Service Level Agreement and the project grant agreement with the EC, the latter will apply.

This Service Level Agreement specifies in transparent and measurable terms the services to be provided, including quality requirements, and the obligations of the Service Provider and of the User respectively.

1. Service description

The Re-Cover project provides pilot services that support efforts to curb deforestation and forest degradation with a particular reference to the REDD (Reducing Emissions from Deforestation and forest Degradation) mechanism. The services use satellite, airborne and *in-situ* data. The services that are funded from the European Commission's and participating organizations' research budgets reach beyond the state-of-the-art, which emphasizes their pilot nature. In addition to strictly serving the monitoring of deforestation and forest degradation, the services will support development of sustainable forestry in general.

In the pilot service novel forest monitoring methods for the monitoring of forest cover and biomass change are being developed, implemented and evaluated.

All the Products and Services hereby mentioned will be developed free of charge to the User in the context of the Re-Cover project, co-founded by the European Commission, in the framework of the FP7-2010 Theme 9-Space call.

2. Obligations of the Service Provider:

- The Service Provider agrees to provide the User with the service according to the Detailed Service Specifications below.
- The Service Provider agrees to ensure adequate quality control is performed.
- The Service Provider agrees to ensure validation is performed according to the agreed Validation Plan.
- The Service Provider agrees to ensure that needed technical support to the User to fully utilise the service will be provided within reasonable limits.

3. Obligations of the User:

- The User agrees to fully participate in the assessment/consolidation of user requirements.
- The User agrees to integrate the service within his operational mandate as far as practically possible.
- The User agrees to fully participate in the assessment of the utility of the service.

4. Detailed Service Specifications

The service to be delivered by the Service Provider to the User has the following contents and characteristics:

Products:

Product	Chiapas State
Image mosaic map of year 1992-1994 (optical)	X
Image mosaic map of year 2004-2011 for baseline	X
Forest/land cover map of year 1992-1994, 2004-2011	X
Forest biomass map of year 1992-1994, 2004-2011	X
Forest degradation map of year 1992-1994, 2004-2011	X
Forest area change map 1992-1994, 2004 – 2011	X
Forest biomass change map 1992-1994, 2004 – 2011	X

Service Area

Selected areas of Chiapas state in Mexico

Other Deliverables

The Service provider organizes annual training for the User according to the training plan in the approved project.

Service Delivery Mode

ftp is the primary alternative for product delivery.
If this is not applicable a DVD delivery with courier will be used.

Delivery Schedule

Image mosaic maps: According to the schedule in the approved project
Thematic maps: According to the schedule in the approved project

The delivery schedule is however subject to image provision by the image distributor agencies.

Product Specifications

Geometric characteristics	**Target***	**Acceptable***
Map projection	UTM	LCC
Geometric accuracy	Subpixel	1.5 pixels
Minimum mapping unit	4 pixels	9 pixels
Class definitions		
Land/forest deforestation cover class: Forest – non forest	overall 90 % prod. acc. 90% user acc 90 %	overall 80 % prod. acc. 80 % user acc 80 %
Land/forest degradation cover class:	overall 80 %	overall 70 %

Low vegetation cover, medium vegetation cover and high vegetation cover	prod. acc. 80 % user acc 80 %	prod. acc. 70 % user acc 70 %
Change class from Forest to Non Forest	overall 80 % prod. acc. 80 % user acc 80 %	overall 70 % prod. acc. 70 % user acc 70 %
Change class from Forest to Forest (degradation)	overall 80 % prod. acc. 80 % user acc 80 %	overall 70 % prod. acc. 70 % user acc 70 %
Biomass (t/ha)	20 % mean stock (t/ha)	30 % mean stock (t/ha)

*The target and acceptable accuracy levels will be re-considered for the next SLA reflecting the pilot nature of the project. It is also possible to relax the figures if user's need change or if achievement of the original target accuracy is too costly, for instance.

To guarantee long-term data accessibility, the Service Provider will deliver the products with a set of metadata deriving from the implementation of the INSPIRE directive of the European Union.

Target Service Delivery Model

The Service Provider aims at outsourcing the service to an industrial party or participate in establishing a user in-house service. The most appropriate service model will be agreed in the successive SLA's.

5. Other terms

- The reserves and credits will be the ones established in the final contract of the approved project.

Service Level Agreement signed by:

On behalf of Re-Cover (the Service Provider)

T. Häme

Dr. Tuomas Häme,
Coordinator, Re-Cover Project
VTT Technical Research Centre of Finland

On behalf of CONAFOR (the User)

Rigoberto Palafox

Ing. Rigoberto Palafox
Head
Forestry Inventory and Geomatics Dept.
CONAFOR, Mexico

Mexico Chiapas state

SERVICE LEVEL AGREEMENT RELATED TO THE RE-COVER PROJECT

First project year

This agreement is concluded between VTT Technical Research Centre of Finland, Finland on behalf of the Re-Cover project consortium, hereafter referred to as the Service Provider, and Programa Mexicano del Carbono (PMC), hereafter referred to as the User for the duration of three years with annual service revision and starting from the project kick-off date (to be defined in the approved project). The project lifecycle will be three years.

The agreement will be applicable only if the project proposal results in a grant agreement with the EC. In case of conflict between this Service Level Agreement and the project grant agreement with the EC, the latter will apply.

This Service Level Agreement specifies in transparent and measurable terms the services to be provided, including quality requirements, and the obligations of the Service Provider and of the User respectively.

1. Service description

The Re-Cover project provides pilot services that support efforts to curb deforestation and forest degradation with a particular reference to the REDD (Reducing Emissions from Deforestation and forest Degradation) mechanism. The services use satellite, airborne and *in-situ* data. The services that are funded from the European Commission's and participating organizations' research budgets reach beyond the state-of-the-art, which emphasizes their pilot nature. In addition to strictly serving the monitoring of deforestation and forest degradation, the services will support development of sustainable forestry in general.

The need accurate information for GHG national inventories is one of the most demanding tasks regarding international efforts. The use of state-of-the-art remote sensing technology is one of the most promising areas of research, especially for expanding national forestry inventories in an exhaustive spatial way.

In the pilot service novel forest monitoring methods for the monitoring of forest cover and biomass change are being developed, implemented and evaluated.

All the Products and Services hereby mentioned will be developed free of charge to the User in the context of the Re-Cover project, co-founded by the European Commission, in the framework of the FP7-2010 Theme 9-Space call.

2. Obligations of the Service Provider:

- The Service Provider agrees to provide the User with the service according to the Detailed Service Specifications below.
- The Service Provider agrees to ensure adequate quality control is performed.
- The Service Provider agrees to ensure validation is performed according to the agreed Validation Plan.
- The Service Provider agrees to ensure that needed technical support to the User to fully utilise the service will be provided within reasonable limits.

3. Obligations of the User:

- The User agrees to fully participate in the assessment/consolidation of user requirements.

- The User agrees to integrate the service within his operational mandate as far as practically possible.
- The User agrees to fully participate in the assessment of the utility of the service.

4. Detailed Service Specifications
The service to be delivered by the Service Provider to the User has the following contents and characteristics:

Products:

Product	Chiapas State
Image mosaic map of year 1992-1994 (optical)	X
Image mosaic map of year 2004-2011 for baseline	X
Forest/land cover map of year 1992-1994, 2004-2011	X
Forest biomass map of year 1992-1994, 2004-2011	X
Forest degradation map of year 1992-1994, 2004-2011	X
Forest area change map 1992-1994, 2004 – 2011	X
Forest biomass change map 1992-1994, 2004 – 2011	X
Calibration/validation of remote sensing estimations (carbon) using sampling sites (all IPCC pools) 1992-1994, 2004-2011	X
Assimilation of remote sensing carbon estimation in Mexico carbon budget of GHG emissions 1992-1994, 2004-2011	X

Service Area

Selected areas of Chiapas state in Mexico

Other Deliverables
The Service provider organizes annual training for the User according to the training plan in the approved project.

Service Delivery Mode

ftp is the primary alternative for product delivery.
If this is not applicable a DVD delivery with courier will be used.

Delivery Schedule

Image mosaic maps: According to the schedule in the approved project
Thematic maps: According to the schedule in the approved project

The delivery schedule is however subject to image provision by the image distributor agencies.

Product Specifications

Geometric characteristics	Target*	Acceptable*

Map projection	UTM	LCC
Geometric accuracy	Subpixel	1.5 pixels
Minimum mapping unit	4 pixels	9 pixels
Class definitions		
Land/forest deforestation cover class: Forest – non forest	overall 90 % prod. acc. 90% user acc 90 %	overall 80 % prod. acc. 80 % user acc 80 %
Land/forest degradation cover class: Low vegetation cover, medium vegetation cover and high vegetation cover	overall 80 % prod. acc. 80 % user acc 80 %	overall 70 % prod. acc. 70 % user acc 70 %
Change class from Forest to Non Forest	overall 80 % prod. acc. 80 % user acc 80 %	overall 70 % prod. acc. 70 % user acc 70 %
Change class from Forest to Forest (degradation)	overall 80 % prod. acc. 80 % user acc 80 %	overall 70 % prod. acc. 70 % user acc 70 %
Biomass (t/ha)	20 % mean stock (t/ha)	30 % mean stock (t/ha)
Calibration/validation exercises for remote sensing estimations using field sampling sites 1992-1994, 2004-2011	± 1 standard deviation	± 1.5 standard deviation
Predictions of the calibated Mexico carbon budget of GHG emissions 1992-1994, 2004-2011	± 1 standard deviation	± 1.5 standard deviation

*The target and acceptable accuracy levels will be re-considered for the next SLA reflecting the pilot nature of the project. It is also possible to relax the figures if user's need change or if achievement of the original target accuracy is too costly, for instance.

To guarantee long-term data accessibility, the Service Provider will deliver the products with a set of metadata deriving from the implementation of the INSPIRE directive of the European Union.

Target Service Delivery Model

The Service Provider aims at outsourcing the service to an industrial party or participate in establishing a user in-house service. The most appropriate service model will be agreed in the successive SLA's.

5. Other terms

- The reserves and credits will be the ones established in the final contract of the approved project.

Service Level Agreement signed by:

On behalf of Re-Cover (the Service Provider)

T. Häme

Dr. Tuomas Häme,
Coordinator, Re-Cover Project
VTT Technical Research Centre of Finland

On behalf of PMC (the User)

Dr. Felipe García-Oliva
Chairman
PMC, Mexico

Mexico Chiapas state

SERVICE LEVEL AGREEMENT RELATED TO THE RE-COVER PROJECT

Background

This agreement is concluded between Wageningen University (WU), the Netherlands on behalf of the Re-Cover project consortium, hereafter referred to as the Service Provider, and the Guyana Forestry Commission, hereafter referred to as the User for the duration of three years with annual service revision and starting from the project kick-off date (to be defined in the approved project). The project lifecycle will be three years.

The agreement will be applicable only if the project proposal results in a grant agreement with the European Commission (EC) for the Recover project proposal. In case of conflict between this Service Level Agreement and the project grant agreement with the EC, the latter will apply.

This Service Level Agreement specifies in transparent and measurable terms the services to be provided, including quality requirements, and the obligations of the Service Provider and of the User respectively.

1. Service description

The Re-Cover project provides pilot services that support efforts to map and monitor changes in forests (invl. Degradation) and forest carbon stocks with a particular reference to the REDD (Reducing Emissions from Deforestation and Forest Degradation) mechanism. The Guyana Forest Commission is requesting this service development and implementation in support of their plan and activities for a REDD monitoring, reporting and verification system. The service further builds upon synergies with ongoing international efforts of the Group on Earth Observations (GEO) Forest Carbon Tracking task, where Guyana is a key demonstration country, and the remote sensing survey of FAO's Forest Resources Assessment 2010 and their sample sites. The services use satellite, airborne and *in-situ* data. The services that are funded from the European Commission's and participating organizations' research budgets reach beyond the state-of-the-art, which emphasizes their pilot nature. In addition to strictly serving the monitoring of deforestation and forest degradation, the services will support development of sustainable forestry in general.

In the pilot service, novel forest monitoring methods for the monitoring of forest cover and biomass change are being developed, implemented and evaluated beyond the current state of the art in terms of using Earth Observation technologies.

All the Products and Services hereby mentioned will be developed free of charge to the User in the context of the Re-Cover project, co-founded by the European Commission, in the framework of the FP7-2010 Theme 9-Space call.

2. Obligations of the Service Provider:

- The Service Provider agrees to provide the User with the service according to the Detailed Service Specifications below.
- The Service Provider agrees to ensure adequate quality control is performed.
- The Service Provider agrees to ensure validation is performed according to the agreed Validation Plan.
- The Service Provider agrees to ensure that needed technical support to the User to fully utilise the service will be provided within reasonable limits.

3. Obligations of the User:

- The User agrees to fully participate in the assessment/consolidation of user requirements.

- The User agrees to integrate the service within his operational mandate as far as practically possible.
- The User agrees to fully participate in the assessment of the utility of the service.

4. Detailed Service Specifications

The service to be delivered by the Service Provider to the User has the following contents and characteristics:

Products:

	Product	**Area**
1	ALOS PALSAR image mosaic map of year 2007-2011	National
2	Forest/land cover map of year 2010/11	Demonstration sites
3	Map products and analysis for forest changes (incl. degradation)	Demonstration sites
4	High resolution forest biomass map of year 2010/11	Test sites

Product 1: This service ensures consistent and continuous coverage of Guyana's forest areas in support of the national REDD implementation strategy of early actions and for national reporting and ensuring compliance given a set of interim performance indicators agreed between the Governments of Guyana and the Norway. The service will be implemented by Wageningen University in cooperation with Sarvision.

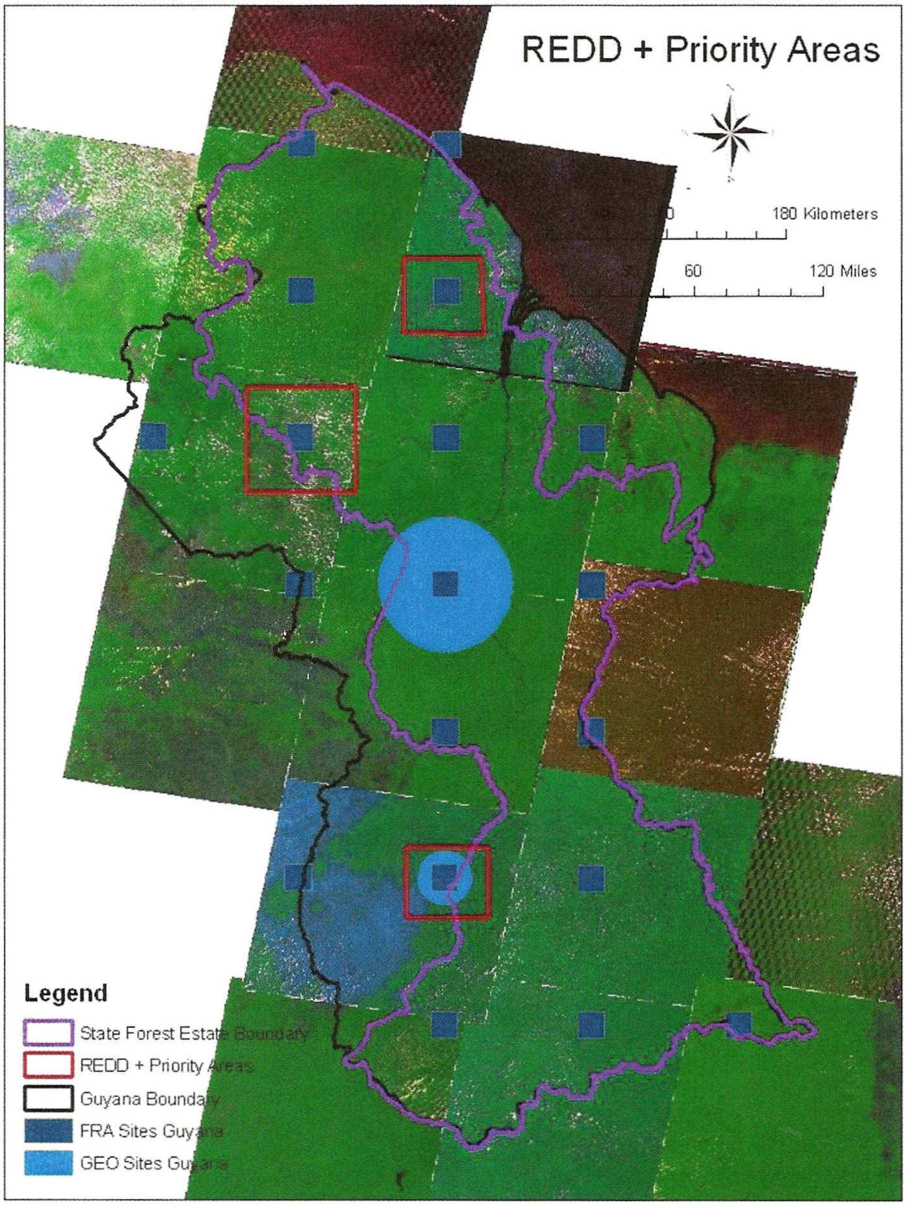
Product 2: This service provides more detail and accuracy in forest area and forest type mapping using optical and Radar satellite data and explores the synergy multiple remote sensing datasets acquired by the GEO and Kyoto and Carbon initiative for that purpose. The service is anticipate in selected demonstration sites that are defined by the user and reflect regions of importance to REDD, GEO task verification sites and FRA 2010 sampling points. The service will be implemented by Wageningen University.

Product 3: This service monitors changes in forest land such deforestation (from different drivers and processes) and forest degradation using a high-temporal (annual) coverage of optical and Radar satellite data acquired by the GEO and Kyoto and Carbon initiative and for that purpose. The service is anticipate in selected demonstration sites that are defined by the user and reflect regions of importance to REDD, GEO task verification sites and FRA 2010 sampling points. The service will be implemented by Wageningen University.

Product 4: This service aims to deliver a high-resolution biomass map using a combination of satellite and in-situ data. The service is anticipate in a selected test site of particular importance for REDD activities as specified by the user.

Service Area

The map below shows the different areas where the different services will be implemented (shown in red). The selection aims to maximize the utility of the service to the user (national REDD implementation roadmap), the synergy with ongoing international activities (GEO, FAO-FRA) and the representativeness to expand the service after successful demonstration. Thus, the purpose is to develop the GMES services in selected and representative areas with the option to expand to full national scale implementation in the post-project period.



Other Deliverables

The Service provider organizes annual training for the User according to the training plan in the approved project.

Service Delivery Mode

Dissemination through ftp is the primary alternative for product delivery. If this is not applicable a DVD delivery with courier will be used.

Delivery Schedule

Image mosaic maps: According to the schedule in the approved project

Thematic maps and analysis: According to the schedule in the approved project

The delivery schedule is however subject to image provision by the image distributor agencies.

Product Specifications

Geometric characteristics	**Target***	**Acceptable***
Map projection	LCC	UTM
Geometric accuracy	Subpixel	1.5 pixels
Minimum mapping unit	4 pixels	9 pixels
Class definitions		
Land/forest deforestation cover class: Forest – non forest	overall 90 % prod. acc. 90% user acc 90 %	overall 80 % prod. acc. 80 % user acc 80 %
Land/forest degradation cover class: Such as low vegetation cover, medium vegetation cover and high vegetation cover	overall 80 % prod. acc. 80 % user acc 80 %	overall 70 % prod. acc. 70 % user acc 70 %
Change class from Forest to Non Forest	overall 80 % prod. acc. 80 % user acc 80 %	overall 70 % prod. acc. 70 % user acc 70 %
Change class from Forest to Forest (degradation)….	overall 80 % prod. acc. 80 % user acc 80 %	overall 70 % prod. acc. 70 % user acc 70 %
Biomass (t/ha)	25 % mean stock (t/ha)	35 % mean stock (t/ha)

*The target and acceptable accuracy levels will be re-considered for the next SLA reflecting the pilot nature of the project. It is also possible to relax the figures if user's need change or if achievement of the original target accuracy is too costly, for instance.

To guarantee long-term data accessibility, the Service Provider will deliver the products with a set of metadata as specified by the user and/or deriving from the implementation of the INSPIRE directive of the European Union.

Target Service Delivery Model

The Service Provider aims at outsourcing the service to an industrial party or participates in establishing a user in-house service. The most appropriate service model will be agreed in the successive SLA's.

5. Other terms

- The reserves and credits will be the ones established in the final contract of the approved project.

Service Level Agreement signed by:

On behalf of Re-Cover (the Service Provider)

Prof. Dr. Martin Herold

On behalf of Guyana Forestry Commission (the User)

James Singh / Forest Commissioner

Commissioner Of Forests
GUYANA FORESTRY COMMISSION

SERVICE LEVEL AGREEMENT RELATED TO THE RE-COVER PROJECT

Background

This agreement is concluded between Wageningen University (WU), the Netherlands on behalf of the Re-Cover project consortium, hereafter referred to as the Service Provider, and the Department of Forestry in Fiji, hereafter referred to as the User for the duration of three years with annual service revision and starting from the project kick-off date (to be defined in the approved project). The project lifecycle will be three years.

The agreement will be applicable only if the project proposal results in a grant agreement with the European Commission (EC) for the Recover project proposal. In case of conflict between this Service Level Agreement and the project grant agreement with the EC, the latter will apply.

This Service Level Agreement specifies in transparent and measurable terms the services to be provided, including quality requirements, and the obligations of the Service Provider and of the User respectively.

1. Service description

The Re-Cover project provides pilot services that support efforts to map and monitor changes in forests (invl. Degradation) and forest carbon stocks with a particular reference to the REDD (Reducing Emissions from Deforestation and Forest Degradation) mechanism. The Fiji Forestry Department is requesting this service development and implementation in support of their plan and activities for a REDD monitoring, reporting and verification system. The service further builds upon synergies with ongoing international efforts of the remote sensing survey of FAO's Forest Resources Assessment 2010 and their sample sites. The services use satellite, airborne and *in-situ* data. The services that are funded from the European Commission's and participating organizations' research budgets reach beyond the state-of-the-art, which emphasizes their pilot nature. In addition to strictly serving the monitoring of deforestation and forest degradation, the services will support development of sustainable forestry in general.

In the pilot service, novel forest monitoring methods for the monitoring of forest cover and biomass change are being developed, implemented and evaluated beyond the current state of the art in terms of using Earth Observation technologies.

All the Products and Services hereby mentioned will be developed free of charge to the User in the context of the Re-Cover project, co-founded by the European Commission, in the framework of the FP7-2010 Theme 9-Space call.

2. Obligations of the Service Provider:

- The Service Provider agrees to provide the User with the service according to the Detailed Service Specifications below.
- The Service Provider agrees to ensure adequate quality control is performed.
- The Service Provider agrees to ensure validation is performed according to the agreed Validation Plan.
- The Service Provider agrees to ensure that needed technical support to the User to fully utilise the service will be provided within reasonable limits.

3. Obligations of the User:

- The User agrees to fully participate in the assessment/consolidation of user requirements.
- The User agrees to integrate the service within his operational mandate as far as practically possible.

- The User agrees to fully participate in the assessment of the utility of the service.

4. Detailed Service Specifications

The service to be delivered by the Service Provider to the User has the following contents and characteristics:

Products:

	Product	**Area**
1	Accuracy assessment for national forest area change assessment	National
2	An updated forest map using a synergy of optical and Radar data	National
3	An pre-processed annual coverage with satellite data	National
4	A detailed analysis for forest change (incl. degradation) in selected areas for recent years	Demonstration sites
5	Biomass mapping using high-resolution optical data	Demonstration sites

Product 1: This service provides a robust, best-efforts accuracy assessment framework and implementation support for the historical in forest area change assessment of Fiji. The assessment itself will be implementation by Fiji partners incl. the user and SOPAC and the service is to develop the methodologies and implement a joint accuracy assessment of the forest area change estimates as required by international IPCC estimation and reporting requirements.

Product 2: This service provides more detail and accuracy in forest area and forest type mapping using optical and Radar satellite data and explores the synergy multiple remote sensing datasets. The service is building upon the forest type map existing for Fiji for the year 2002 and is anticipated for the main island as defined by the user and will be validated in regions of importance to REDD and FRA 2010 sampling points.

Product 3: This service provides a prototype on consistent and continuous satellite coverage using multiple observing sources of Fiji forest areas in support of the national REDD implementation strategy of early actions and for national reporting and ensuring compliance.

Product 4: This service monitors changes in forest land such deforestation (from different drivers and processes) and forest degradation using a high-temporal (i.e. annual) coverage of optical and Radar satellite data acquired. The service is focused in selected demonstration sites that are defined by the user and reflect regions of importance to REDD and FRA 2010 sampling points.

Product 5: This service aims to deliver a high-resolution biomass map using a combination of satellite and in-situ data. The activities will build upon the ongoing capacity development activities in Fiji to provide, for the first time, forest carbon and biomass data. The service is focused in a selected test site of particular importance for REDD activities as specified by the user. The service will be implemented by … .

Service Area

Different areas are designted for developing the services. The selection aims to maximize the utility of the service to the user (national REDD implementation roadmap), the synergy with ongoing international activities (FAO-FRA) and the representativeness to expand the service after successful demonstration. Thus, the purpose is to develop the GMES services targets the national level and selected and representative areas with the option to expand some services to full national scale implementation in the post-project period.

Other Deliverables

The Service provider organizes annual training for the User according to the training plan in the approved project.

Service Delivery Mode

Dissemination through ftp is the primary alternative for product delivery. If this is not applicable a DVD delivery with courier will be used.

Delivery Schedule

Image mosaic maps: According to the schedule in the approved project
Thematic maps and analysis: According to the schedule in the approved project

The delivery schedule is however subject to image provision by the image distributor agencies.

Product Specifications

Geometric characteristics	**Target***	**Acceptable***
Map projection	LCC	UTM
Geometric accuracy	Subpixel	1.5 pixels
Minimum mapping unit	4 pixels	9 pixels
Class definitions		
Land/forest deforestation cover class: Forest – non forest	overall 90 % prod. acc. 90% user acc 90 %	overall 80 % prod. acc. 80 % user acc 80 %
Land/forest degradation cover class: Such as low vegetation cover, medium vegetation cover and high vegetation cover	overall 80 % prod. acc. 80 % user acc 80 %	overall 70 % prod. acc. 70 % user acc 70 %
Change class from Forest to Non Forest	overall 80 % prod. acc. 80 % user acc 80 %	overall 70 % prod. acc. 70 % user acc 70 %
Change class from Forest to Forest (degradation)….	overall 80 % prod. acc. 80 % user acc 80 %	overall 70 % prod. acc. 70 % user acc 70 %
Biomass (t/ha)	25 % mean stock (t/ha)	35 % mean stock (t/ha)

*The target and acceptable accuracy levels will be re-considered for the next SLA reflecting the pilot nature of the project. It is also possible to relax the figures if user’s need change or if achievement of the original target accuracy is too costly, for instance.

To guarantee long-term data accessibility, the Service Provider will deliver the products with a set of metadata as specified by the user and/or deriving from the implementation of the INSPIRE directive of the European Union.

Target Service Delivery Model

The Service Provider aims at outsourcing the service to an industrial party or participates in establishing a user in-house service. The most appropriate service model will be agreed in the successive SLA's.

5. Other terms

- The reserves and credits will be the ones established in the final contract of the approved project.

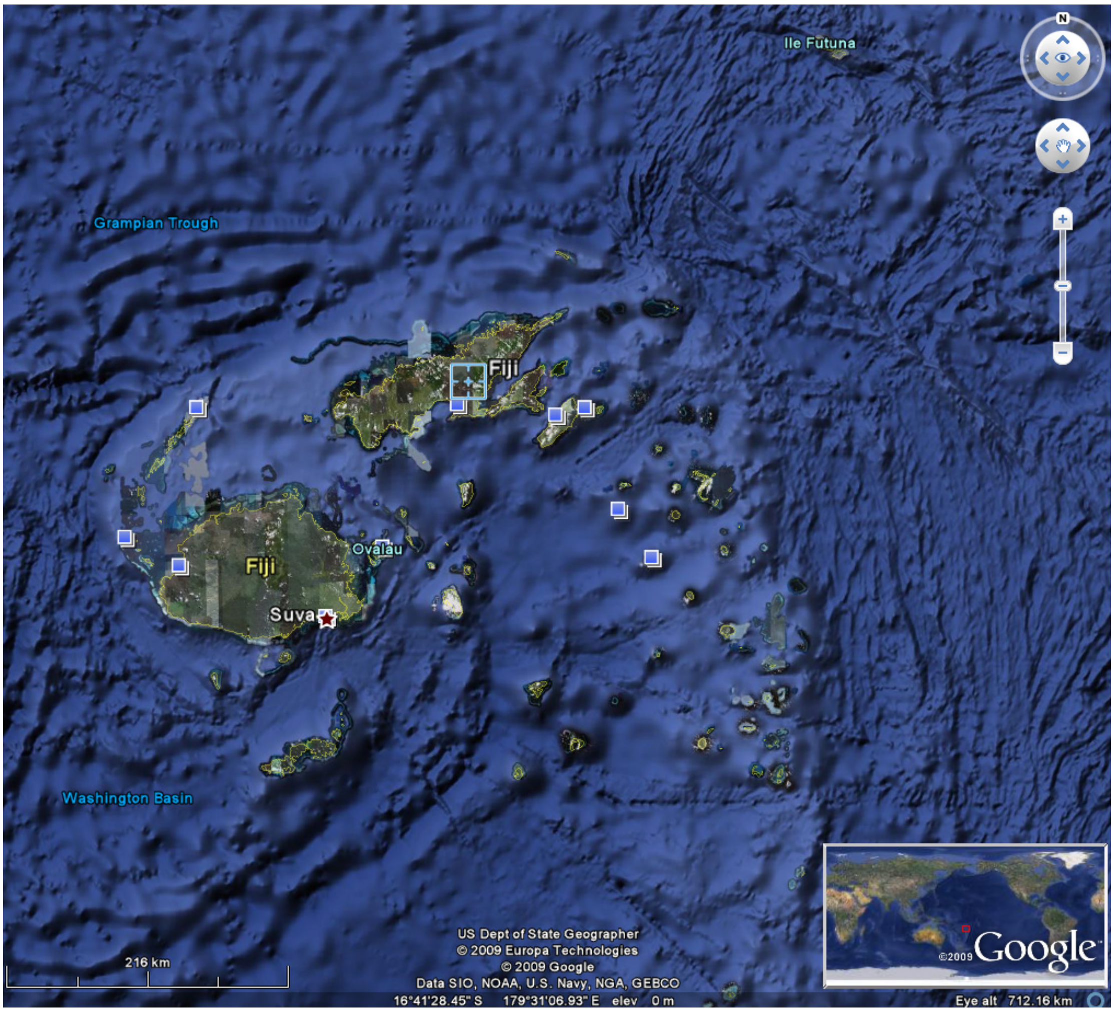
Service Level Agreement signed by:

On behalf of Re-Cover (the Service Provider)

Prof. Dr. Martin Herold

On behalf of Fiji Forestry Department (the User)

Mr. Viliame Naupoto
Permanent Secretary for Fisheries and Forests


Ile Futuna
Grampian Trough
Fiji
Ovalau
Fiji
Suva
Washington Basin
US Dept of State Geographer
© 2009 Europa Technologies
© 2009 Google
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
216 km
16°41'28.45" S 179°31'06.93" E elev 0 m
Eye alt 712.16 km
©2009 Google

Fiji

SERVICE LEVEL AGREEMENT RELATED TO THE RE-COVER PROJECT
First project year

This agreement is concluded between the **Northern Research Institute Tromsø (Norut)** on behalf of the Re-Cover project consortium, hereafter referred to as the Service Provider, and the **Instituto Nacional de Pesquisas Espaciais (INPE)**, hereafter referred to as the User for the duration of three years with annual service revision and starting from the project kick-off date. The project lifecycle will be three years.

The agreement will be applicable only if the project proposal results in a grant agreement with the EC. In case of conflict between this Service Level Agreement and the project grant agreement with the EC, the latter will apply.

This Service Level Agreement specifies in transparent and measurable terms the services to be provided, including quality requirements, and the obligations of the Service Provider and of the User respectively.

1. Service description
The Re-Cover project provides pilot services that support efforts to curb deforestation and forest degradation with a particular reference to the REDD (Reducing Emissions from Deforestation and forest Degradation) mechanism. The services use satellite, airborne and *in-situ* data. The services that are funded from the European Commission's and participating organizations' research budgets reach beyond the state-of-the-art, which emphasizes their pilot nature. In addition to strictly serving the monitoring of deforestation and forest degradation, the services will support development of sustainable forestry in general.

In the pilot service novel forest monitoring methods for the monitoring of forest cover and biomass change are being developed, implemented and evaluated.

All the Products and Services hereby mentioned will be developed free of charge to the User in the context of the Re-Cover project, co-funded by the European Commission, in the framework of the FP7-2010 Theme 9-Space call.

2. Obligations of the Service Provider:

- The Service Provider agrees to provide the User with the service according to the Detailed Service Specifications below.
- The Service Provider agrees to ensure adequate quality control is performed.
- The Service Provider agrees to ensure validation is performed according to the agreed Validation Plan.
- The Service Provider agrees to ensure that needed technical support to the User to fully utilise the service will be provided within reasonable limits.

3. Obligations of the User:

- The User agrees to fully participate in the assessment/consolidation of user requirements.
- The User agrees to integrate the service within his operational mandate as far as practically possible.
- The User agrees to fully participate in the assessment of the utility of the service.
- Support the validation beyond the utility assessment, e.g. taking part in accuracy assessments
- Provide access to user-owned or -operated data gathering infrastructure, other equipment or software, specifically the facilities already made available by INPE on the internet (CBERS data, PRODES, etc.).

- In-kind contribution from the user including lobbying support to access third party funding, promotion of service capabilities and utility to collaborating organisations within the same demand sector and operation and maintenance of in-situ data gathering networks and service support infrastructure (e.g. data warehouses)].

4. Detailed Service Specifications
The service to be delivered by the Service Provider to the User has the following contents and characteristics:

Products:

Product	**Tapajós, Pará State**
Image mosaic map of year 1990, 2000, 2010 (optical)	X
Image mosaic map of year 1990s, 2005, 2010 (SAR)	X
Forest/land cover map of year 1990, 2000, 2010	X
Forest biomass map of year 2010	X
Forest degradation map of year 1990-2000, 2000-2010	X
Forest area change map 1990-2000, 2000-2010	X

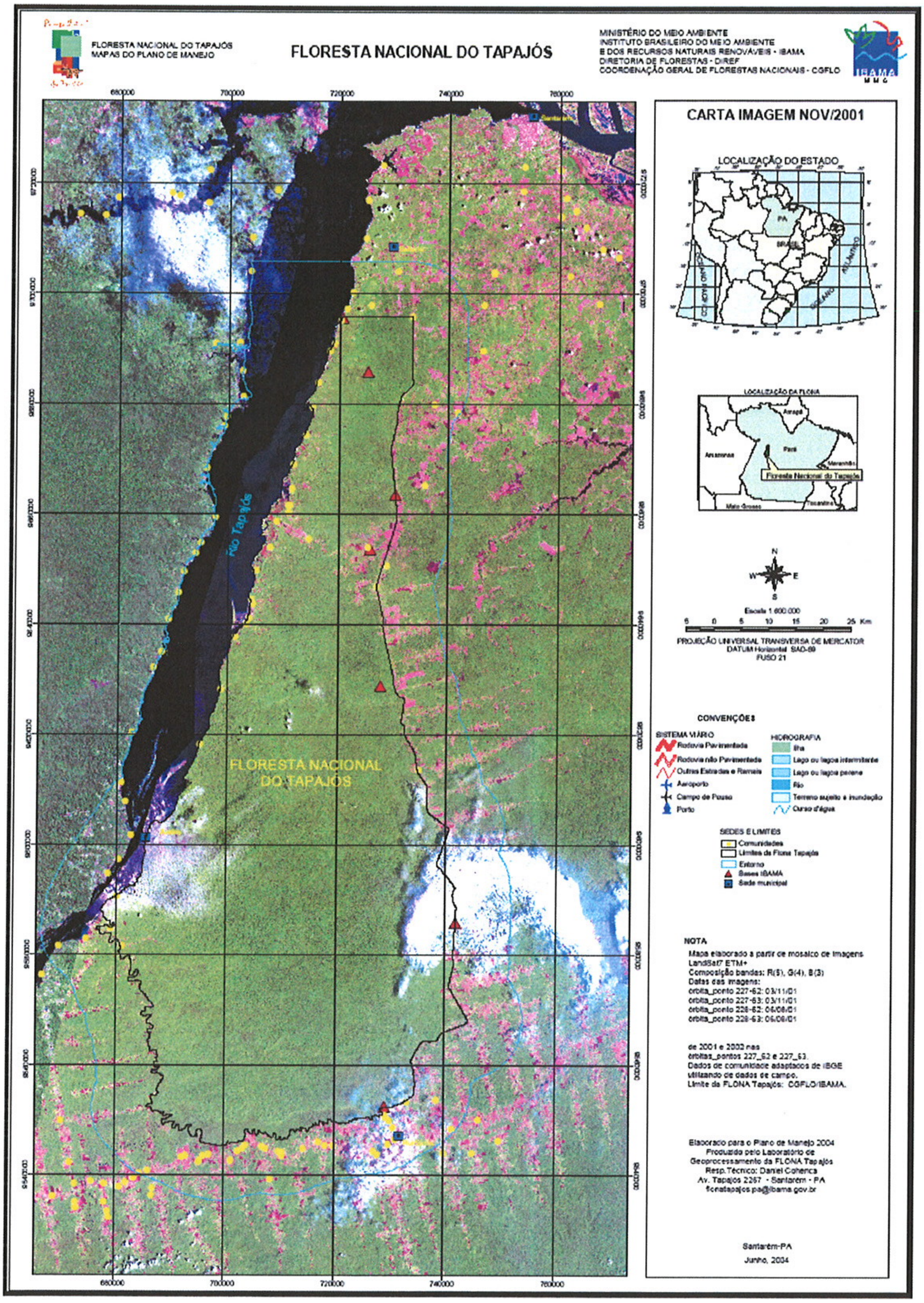
Service Area:
Tapajós, Pará state, Brazil
For the Tapajós study area, the coverage can be similar to the Landsat WRS 227/62 and 227/63, which covers around 43000 km2 (120 km x 360 km, extent of 2 Landsat images). The delivered products will be inside this area (UTM coordinates around 680000, 9720000 and 760000,9540000, see attached map). Although it is not an area of a very dynamic land use, there is the contrast between a protected area (Tapajos National Forest) and surroundings (with plenty of crops and grazing activities). Also, since 2002 timber exploitation inside the Forest is allowed, which can be a source of interesting data for forest degradation studies.

(Alternative area: Boca do Acre, Amazonas State, Brazil)

Other Deliverables
The Service provider organizes annual training for the User according to the training plan. The first training will be organized in the context of the delivery of the first map product (T0+11)

Service Delivery Mode
ftp is the primary alternative for product delivery.
If this is not applicable a DVD delivery with courier will be used.

Delivery Schedule
Image mosaic maps: According to the schedule in the approved project
Thematic maps: According to the schedule in the approved project.
The delivery schedule is however subject to image provision by the image distributor agencies.


FLORESTA NACIONAL DO TAPAJÓS
MAPAS DO PLANO DE MANEJO
FLORESTA NACIONAL DO TAPAJÓS
MINISTÉRIO DO MEIO AMBIENTE
INSTITUTO BRASILEIRO DO MEIO AMBIENTE
E DOS RECURSOS NATURAIS RENOVÁVEIS - IBAMA
DIRETORIA DE FLORESTAS - DIREF
COORDENAÇÃO GERAL DE FLORESTAS NACIONAIS - CGFLO
IBAMA
680000
700000
720000
740000
760000
Rio Tapajós
FLORESTA NACIONAL DO TAPAJÓS
CARTA IMAGEM NOV/2001
LOCALIZAÇÃO DO ESTADO
PA
BRASIL
LOCALIZAÇÃO DA FLONA
Amapá
Amazonas
Pará
Maranhão
Floresta Nacional do Tapajós
Mato Grosso
Tocantins
N
W
E
S
Escala 1:600.000
5 0 5 10 15 20 25 Km
PROJEÇÃO UNIVERSAL TRANSVERSA DE MERCATOR
DATUM Horizontal SAD-69
FUSO 21
CONVENÇÕES
SISTEMA VIÁRIO
Rodovia Pavimentada
Rodovia não Pavimentada
Outras Estradas e Ramais
Aeroporto
Campo de Pouso
Porto
HIDROGRAFIA
Ilha
Lago ou lagoa intermitente
Lago ou lagoa perene
Rio
Terreno sujeito a inundação
Curso d'água
SEDES E LIMITES
Comunidades
Limites da Flona Tapajós
Entorno
Bases IBAMA
Sede municipal
NOTA
Mapa elaborado a partir de mosaico de imagens
LandSat7 ETM+
Composição bandas: R(5), G(4), B(3)
Datas das imagens:
órbita_ponto 227-62: 03/11/01
órbita_ponto 227-63: 03/11/01
órbita_ponto 228-62: 06/08/01
órbita_ponto 228-63: 06/08/01
de 2001 e 2002 nas
órbitas_pontos 227_62 e 227_63.
Dados de comunidade adaptados de IBGE
utilizando de dados de campo.
Limite da FLONA Tapajós: CGFLO/IBAMA.
Elaborado para o Plano de Manejo 2004
Produzido pelo Laboratório de
Geoprocessamento da FLONA Tapajós
Resp.Técnico: Daniel Cohenca
Av. Tapajós 2267 - Santarém - PA
flonatapajos.pa@ibama.gov.br
Santarém-PA
Junho, 2004

Product Specifications

Geometric characteristics	Target*	Acceptable*
Map projection	UTM	LCC
Geometric accuracy	Subpixel	1.5 pixels
Minimum mapping unit	4 pixels	9 pixels
Class definitions		
Land/forest deforestation cover class: Forest – non forest	overall 90 % prod. acc. 90% user acc 90 %	overall 80 % prod. acc. 80 % user acc 80 %
Land/forest degradation cover class: Low vegetation cover, medium vegetation cover and high vegetation cover	overall 80 % prod. acc. 80 % user acc 80 %	overall 70 % prod. acc. 70 % user acc 70 %
Change class from Forest to Non Forest	overall 80 % prod. acc. 80 % user acc 80 %	overall 70 % prod. acc. 70 % user acc 70 %
Change class from Forest to Forest (degradation)	overall 80 % prod. acc. 80 % user acc 80 %	overall 70 % prod. acc. 70 % user acc 70 %
Biomass (t/ha)	-	-

*The target and acceptable accuracy levels will be re-considered for the next SLA reflecting the pilot nature of the project. It is also possible to relax the figures if user's need change or if achievement of the original target accuracy is too costly, for instance.
To guarantee long-term data accessibility, the Service Provider will deliver the products with a set of metadata deriving from the implementation of the INSPIRE directive of the European Union.

Target Service Delivery Model

The Service Provider aims at outsourcing the service to an industrial party or participates in establishing a user in-house service. The most appropriate service model will be agreed in the successive SLA's.

[Outsourced service or User in-house service (the Service Provider performs development and technology transfer / user capacity building in the project and plans for future revenues from maintenance and/or further development of the processing chain)]

Service Level Agreement signed by:

Dr Jörg Haarpaintner
Senior Scientist at Norut
On behalf of Re-Cover (the Service Provider)

Dra Tatiana Mora Kuplich
Senior Scientist at INPE
On behalf of INPE (the User)

SERVICE LEVEL AGREEMENT RELATED TO THE RE-COVER PROJECT
First project year

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- In-kind contribution from the user including lobbying support to access third party funding, promotion of service capabilities and utility to collaborating organisations within the same demand sector and operation and maintenance of in-situ data gathering networks and service support infrastructure (e.g. data warehouses)].

4. Detailed Service Specifications

The service to be delivered by the Service Provider to the User has the following contents and characteristics:

Products:

Product	**DRC* ND site**
Image mosaic map of year 1990, 2000, 2010 (optical)	X
Image mosaic map of year 2000, 2005, 2010 (SAR)	X
Forest/land cover map of year 1990, 2000, 2010	X
Forest biomass map of year 2010	X
Forest degradation map of year 1990, 2000, 2010	X
Forest area change map 1990-2000, 2000-2010	X

*** DRC = Democratic Republic of Congo**

Service Area

The service area will be in the Democratic Republic of Congo (DRC) inside the area shown on the map below (Figure 1) bounded by:

- the Congo River to the west,
- Lake Mai Ndombe (DRC) (1° 42' S, 18° 17' E) to the east,
- the city of Mbandaka (DRC) (0° 2' N, 18°15' E) in the north, and,
- the city of Bandundu (DRC) (3° 18' S, 17°23' E) in the south.

This area (suggested as a National Demonstrator Site for GEO FCT), approximately bounded by the Congo River to the west, Lake Mai Ndombe on the east, and the cities of Mbandaka and Bandundu to the north and south respectively, contains swamp or flooded forest as well as upland forest / savanna mosaic. It also contains the newly created Tumba Ledima Reserve. According to our sources, this area is accessible for field data collection. In addition, this is an area for which forest cover and change has been mapped by South Dakota State University / UMD using MODIS and Landsat data as part of their basin wide mapping activities; and forest type has been mapped by UCL/JRC using SPOT data.

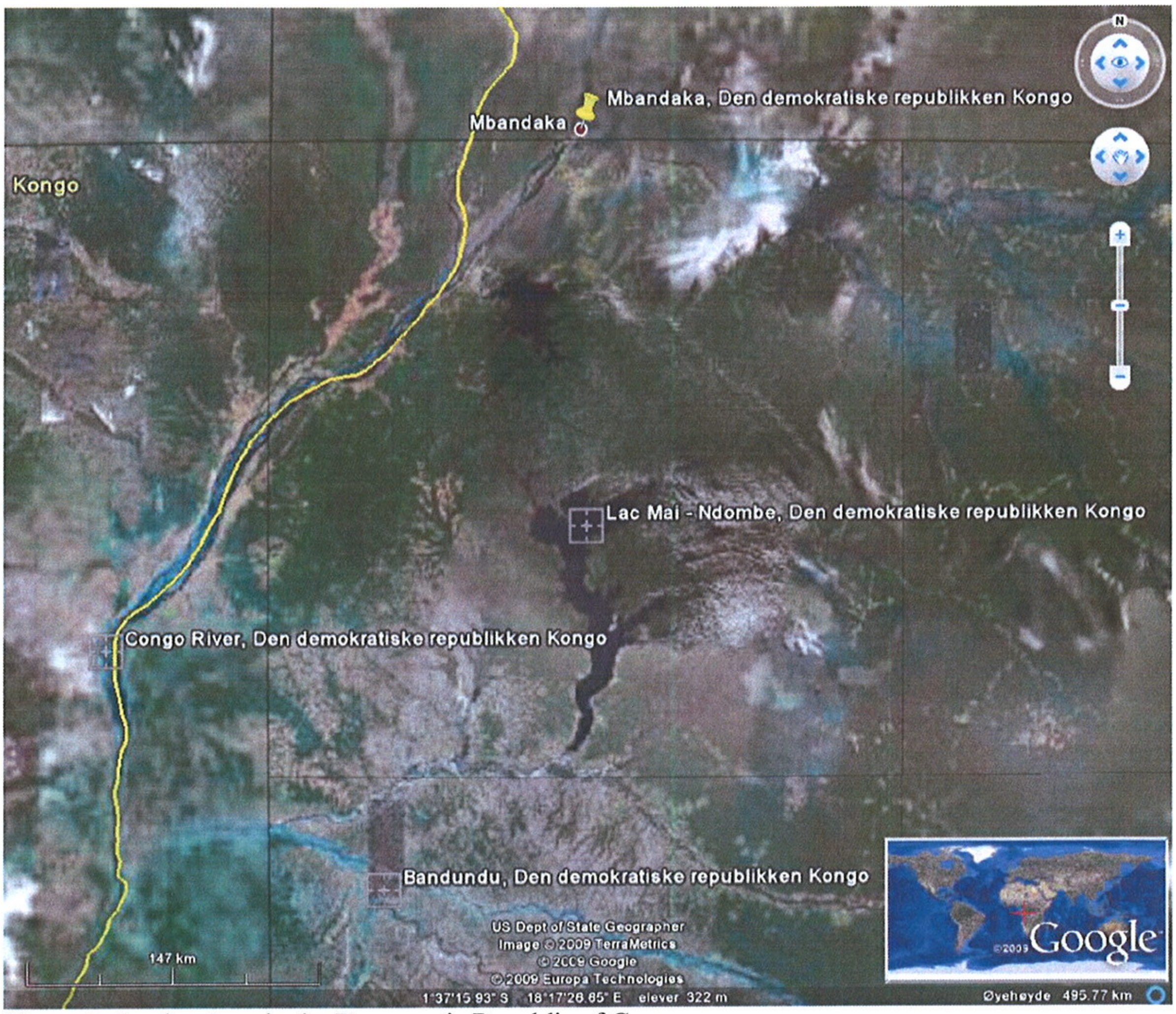

Figure 1: Service Area in the Democratic Republic of Congo

Other Deliverables

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Biomass (t/ha)	-	-

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Target Service Delivery Model

The Service Provider aims at outsourcing the service to an industrial party or participates in establishing a user in-house service. The most appropriate service model will be agreed in the successive SLA's.
[Outsourced service or User in-house service (the Service Provider performs development and technology transfer / user capacity building in the project and plans for future revenues from maintenance and/or further development of the processing chain)]

5. Other terms

- [Restrictions on use of the products and services delivered or of the items provided by the user to the Service Provider; credits / copyright statements; other terms of access, ...]
- [Licensing and maintenance agreements for service generation and delivery infrastructure provided by the service network where service generation is undertaken in-house];
- [Service performance levels, back-up provisions and recovery procedures and timescales];

Service Level Agreement signed by:

On behalf of the Re-Cover consortium

Dr Jörg Haarpaintner
(Senior scientist at Norut)

On behalf of OSFAC

Dr Landing Mane
OSFAC Director

ADMINISTRATION OSFAC COMPTABILITE