



GROOM

Gliders for Research, Ocean Observation and Management

FP7-Infra-2011-2.1.1 “Design Studies”

Deliverable D5.7

**Report describing costs to build and operate the
glider observatory infrastructure**

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Project website address <http://www.groom-fp7.eu>

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I. Introduction and methodology

This deliverable is based on the response to the GROOM questionnaire (see Appendix) from the partners operating gliders and on the recommendations of the WP5 tasks. This questionnaire has been first elaborated for 2011 for JERICO project, then improved for GROOM for 2012 and 2013. The questionnaire asked about the investment, operational and personnel costs associated with running glider facilities in 2011, 2012 and 2013.

Questionnaire responses provide the only available estimate of glider-related expenses in Europe. However, funding available for investment in gliders or gliders operations can vary from year to year. Moreover, the cost of operations can vary depending on the type of mission, for example for coastal vs. open sea, multi gliders vs. single glider, monitoring vs. specific experiment and Mediterranean vs. Arctic operations. Each partner has had a different pattern of growth and mix of mission types, so the responses must be interpreted with caution.

Nineteen partners were involved in the GROOM project. Their names are listed below alphabetically:

- AWI (Alfred Wegener Institute, Germany)
- CMRE (Center for Marine Research and Experimentation, Italy and NATO)
- CNRS (Centre National de la Recherche Scientifique, France)
- CSIC (Consejo Superior de Investigaciones Cientificas, Spain)
- FMI (Finnish Meteorological Institute)
- HCMR (Hellenic Center for Marine Research, Greece)
- HZG (Helmholtz-Zentrum Geesthacht, Germany)
- IFREMER (Institut Français de Recherche pour l'Exploitation de la Mer, France)
- IFM-Geomar (Germany)
- NERC (Natural Environment Research Council, Great Britain)
- NERSC (Nansen Environmental and Remote Sensing Center, Norway)
- OC-UCY (Oceanographic Centre, University of Cyprus)
- OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Italy)
- PLOCAN (Oceanic Platform of the Canary Island)
- SAMS (Scottish Association for Marine Science, Scotland)
- UEA (University of East Anglia, Great Britain)
- UIB (University of Bergen, Norway)
- UPMC (University Pierre et Marie Curie, France)
- UT (University of Trier, Germany)

Gliders operations can be clustered mainly in two types:

01/12/2014

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- "Endurance lines" operations, which implies only one glider at sea, is the repetition of the glider's run several times during the mission between two points. It is associated to monitoring concept.
- "Focused studies" operations, which implies a glider fleet (up to 16) is dedicated to study a particular process or set of phenomena.

The two types operations are not independent, and a mixture for a single mission is often established. The objectives of glider missions vary among partners and over time.

Partners	Mission Type		Comments
	Endurance L	Processes S	
AWI	80%	20%	Deployment of 2 gliders per year, always coupled with other missions (CTD, moorings, geophysics, biology, ...), often in Arctic
CMRE	NA	NA	Use of gliders coupled with others missions, as part of a bigger experiment. Gliders are commonly used in fleets ranging from 3 to 16 units
CNRS	65%	35%	Endurance lines, process studies, local (Mediterranean) and remote locations (Peru, New Caledonia, Senegal, ...)
CSIC	80%	20%	Endurance lines, local, coupled with ship cruises, transnational access (external users)
HZG	2011,2012: 100%	2013: 100%	One to four local deployments, mostly transects for 2, up to 5 weeks
IFM-GEOMAR	10%	90%	Process studies, one deployment per glider either in conjunction with ship missions or in area surveys, often remote locations
NERC	NA	NA	Some long science missions up to 3-4 months. Some short science or trials missions of days or weeks
OC-UCY	95%	5%	One or two deployments per year for endurance lines of about 6 months

			each
OGS		100%	A deployment a year in the same location and also coupled with another mission
PLOCAN	70%	30%	Local, endurance lines mainly
SAMS	2011: 100%	2012,2013: 100%	Mainly endurance lines
UEA		100%	Typically process studies, often remote locations

Table 1: Type of mission for the GROOM partners

There are various types or models of glider facilities currently in Europe: institutional level, national/regional level, European, and SME. See GROOM Deliverable 5.1 *Ground segment description and the glider port concept*. Up to the present day, only France and Norway have centralized their glider fleet into a single national glider port or "glider pool." Spain has invested in two regional level glider ports, located on Mallorca and Gran Canaria, serving the Mediterranean and Atlantic Ocean, respectively. UK and Italy use a mix of centralized facilities (MARS, RITMARE) and institutional glider ports. Other partners are institutional ports. The associated costs vary widely among the institutions. The size of the pool of gliders belonging to the partner is widely different (figure 1). A partner using a glider from time to time does not need a lot of gliders but this is not the case for a partner which has to maintain several endurance lines with several gliders in water at the same time. Also, it must be able to replace a glider if it is broken.

Besides the fact that the size of the pool of gliders belonging to each partner is different, the gliders are not operated in the same way, which can make differences for the cost of data telemetry and batteries. For example, some teams prefer to sample more frequently or send more data in real time than others. One difference arising from the type of glider port model is that the number of missions and the number of days of gliders at sea varies (figs.3, 4).

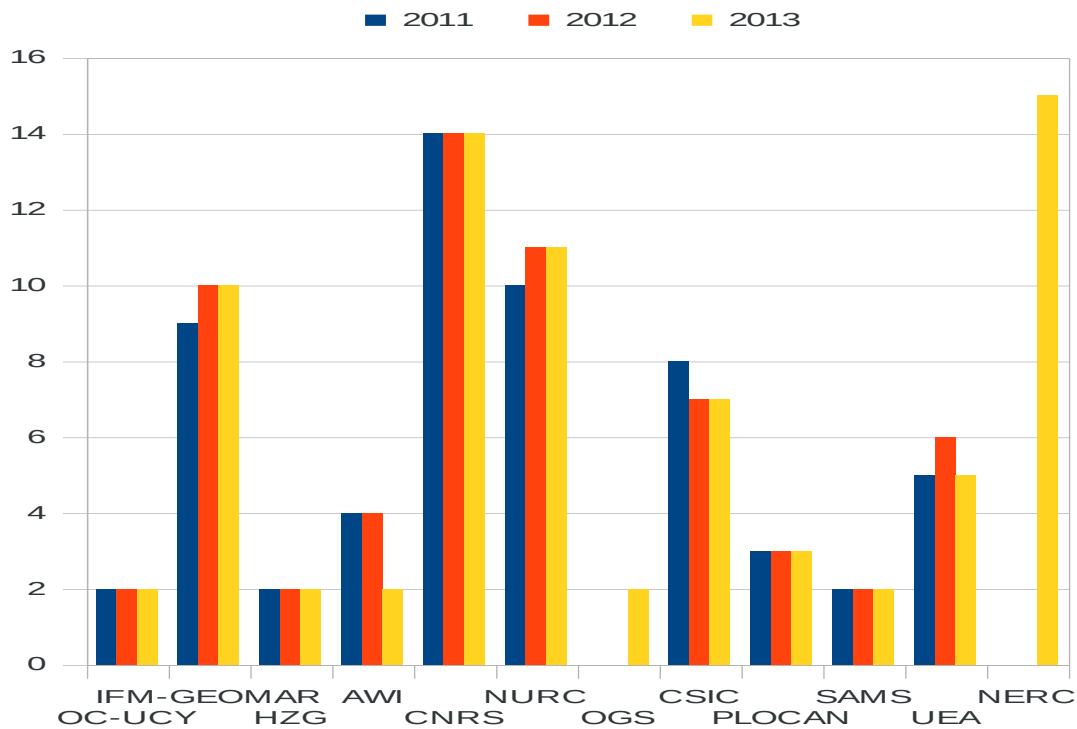


figure 1: Number of gliders belonging to each partner

F

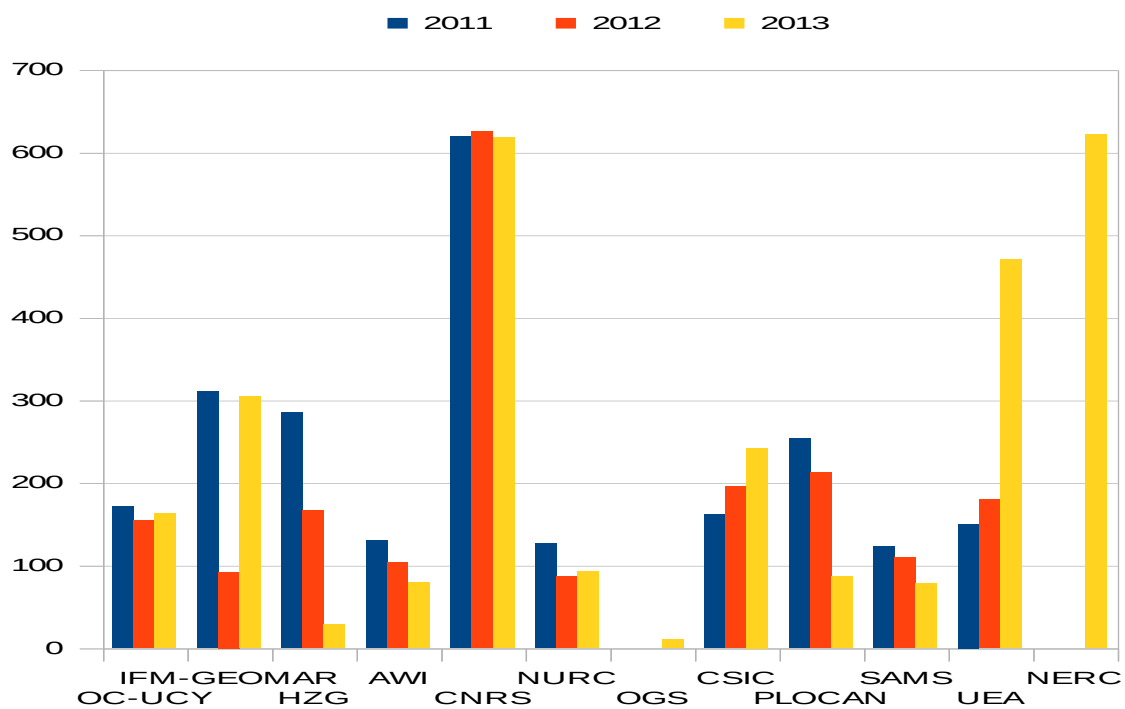


Figure 2: Number of days in water for gliders

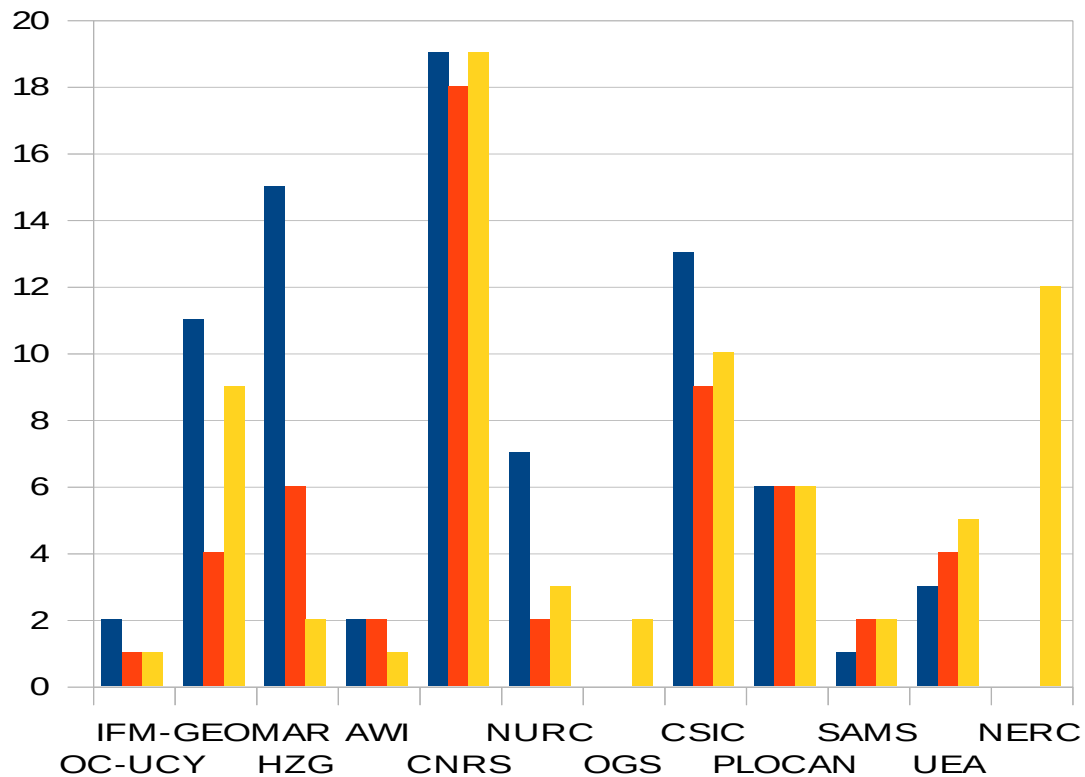


Figure 3: Numbers of missions per year

Therefore, we analyze the costs of a glider infrastructure in terms of:

- Infrastructure (building, ballasting and calibrating facilities, software development, equipment purchase for outfitting “gliderports”),
- Infrastructure operations (engineering and IT staff, building running costs, consumables),
- Operating the gliders which implies:
 - Owning gliders (depreciation),
 - Preparing gliders (ballasting, battery change, compass calibration),
 - Testing and deploying gliders (transportation, use of ship or rubber boat),
 - Piloting gliders (engineering/technician/IT staff),
 - Recovering gliders (transportation, use of ship or rubber boat),
 - Maintaining gliders and sensors (repair, send the glider to manufacturer, calibration of sensors, etc.),

- Integrating new sensors on gliders,
- Transmitting data and metadata to data assembly centers and scientists (telemetry).

It is important to know that it is difficult to make conclusions based on the results of a questionnaire. Indeed, according to the institute and the person who is going to answer it, questions might be understood differently. This can be seen in the given answers. Consequently, it might cause a bias in answers.

The survey was sent to the 19 partners. Six partners did not operate gliders (UPMC, UT, FMI, IFREMER, HCMR and NERSC). Sometimes they use gliders belonging to other partners. HCMR does not yet have gliders but they have set up a calibration facility so they have helped estimate its cost for glider sensors. Therefore, this study is based on the responses of 12 partners for the years 2011, 2012 and 2013. In 2011 and 2012, NERC and OGS did not operate gliders.

For the year 2011, the answers of the JERICO survey for OC-UCY, AWI, CNRS, CMRE, CSIC and SAMS were used.

Some answers concerning the salary cost were missing because it was too difficult for these partners to extract this information (UEA). The same problem was present for the building running costs.

It is clearly impossible to specify exactly how much a glider infrastructure costs in general because there is no single set up, but in this report it is useful to examine the various components of glider infrastructure and their historical costs in the various usage models that exist.

What we consider as a glider infrastructure is the set of all the necessary components for a glider deployment. It is summarized in fig 4.

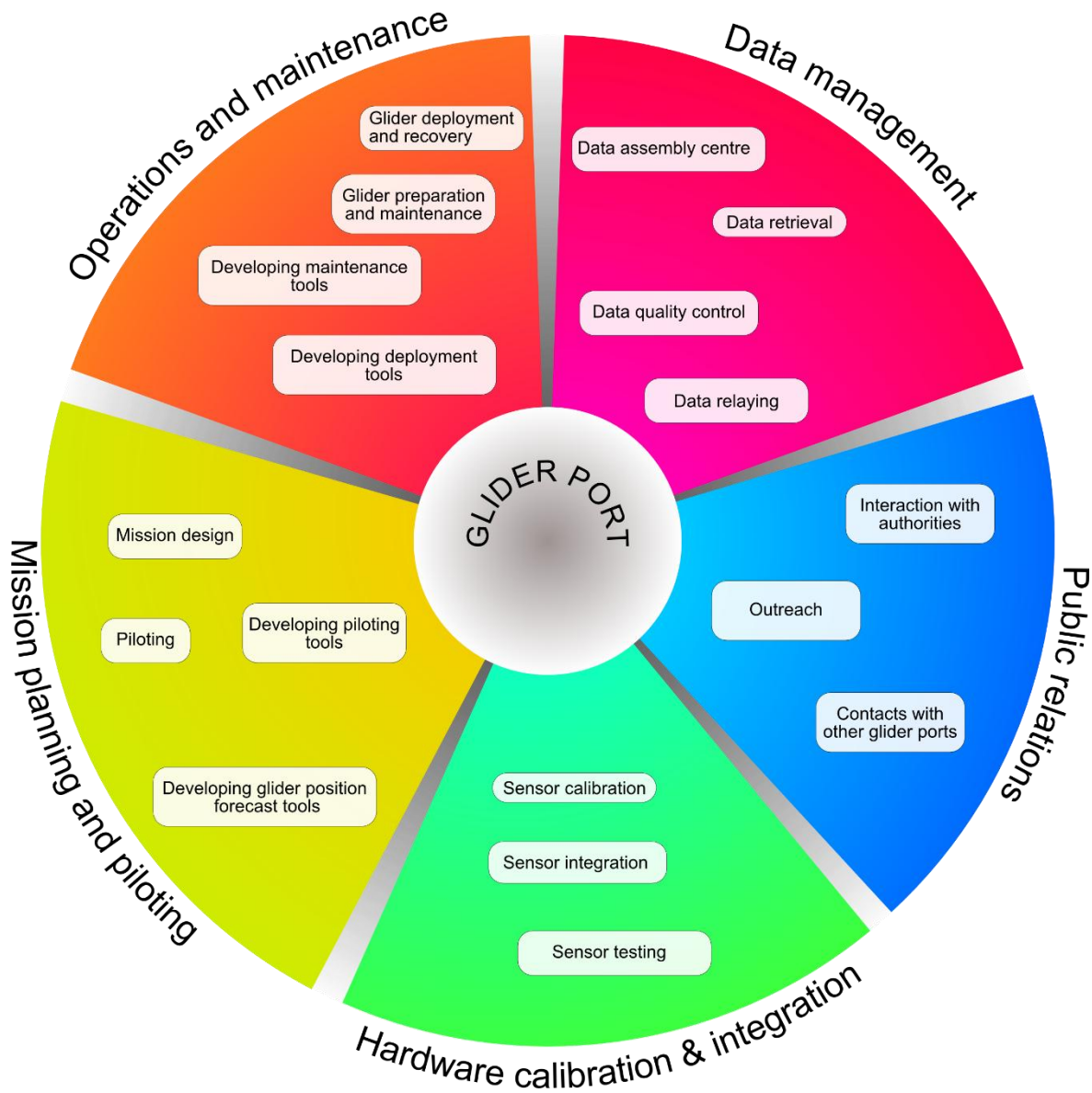


Figure4: Glider Infrastructure scheme

To estimate the cost, the following are considered:

- What is essential to deploy a glider,
- What would be very useful to have (for an intensive use of gliders).

After the description of the method of collecting the financial information, section II is an analysis of the costs for the years 2011, 2012 and 2013 in terms of:

- Investment costs: New building, tools, gliders, sensors, computers, safety equipment

- Running costs: Building, salaries, maintenance, calibration, batteries, communications (internet, Iridium, Argos, phone).

Section III is an estimation of the typical cost for setting up a new glider port of each type: bare essential and intensive use. Section IV provides estimates for the preparation and operation of gliders. In conclusion, the implications of the cost estimates and the future development of a European glider infrastructure are discussed.

II. Cost analysis

In this section, we analyze the money spent by the partners for their glider activity. First, we look at total costs by the consortium, then by partner, over the three years included here. Secondly, we separate costs to "investment" and "running" and examine how those distributions change among the partners over time. Finally, we look at how distributions of investments and running costs change over time (for the consortium as a whole).

In March 2013, GROOM partners were sent a cost survey (see Appendix) and requested:

- To describe their setup for Iridium communications
- To state for each year:
 - The list of the gliders they had at the begin of the year (name, cost, year of purchase)
 - How many gliders they bought (name, cost)
 - The equipment they bought this year (name, cost, % of use for glider application, year of purchase)
 - How many missions at sea they accomplished
 - How many days at sea they accomplished
 - How many full time equivalents from their institute were working with gliders (scientists, technicians, engineers, IT, management, other)
 - To state their annual operating budget for :
 - Purchase of gliders
 - Purchase of sensors
 - Glider infrastructure (e.g. Pressure chamber, rubber boat, ...)
 - Glider equipment (e.g. tools, R&D, ...)
 - Safety equipment
 - Batteries
 - Iridium
 - Argos

- Other consumables
- Other communications
- Spare parts / repairs
- Calibration
- Vessel hire
- Transportation of equipment
- Permanent people
- Contracted people
- People travel
- People training
- People piloting
- Outsourced piloting
- Data center cost
- Shipping insurance
- Glider loss insurance
- Liability insurance
- Other insurance
- Waste disposal
- Other
- Indirect cost / overhead (estimate)

Subsequently, other questions were sent to partners to complete the questionnaire cost.

For each year, the following are identified:

- The investment / partner (a),
- The running costs / partner (b),
- The total distribution of the investment,
- The total distribution of the running costs,
- For the running costs, the total distribution of the consumables and the people costs.

(a) Investment costs are defined below as:

- Purchase of gliders,
- Purchase of sensors,
- Glider infrastructure (for example new building, glider lab),
- Glider equipment,
- Other.

(b) The running costs are defined below as:

- Consumables : Batteries, Iridium, Argos, spare parts/repairs, waste disposal, calibration, other,
- Transportation : Vessel hire, shipping of equipment, other,
- People : Salaries for permanent, salaries for contracted, travel, training, piloting, outsourced piloting, other,
- Insurance: Shipping, glider loss, liability, other.

The GROOM partners comprise the major players of glider activity in Europe. All the institutes/universities owning and using this technology have replied to the questionnaire, implying that the collected data are representative of the actual spent money in this activity.

(Millions of €)	2011	2012	2013
Investments	1.66	2.23	2.91
Running cost	1.32	2.52	3.23
(...of which salaries)	(0.81)	(1.93)	(2.01)
Total	2.98	4.75	6.14

Table 2: Financial activity of glider infrastructure in Europe

Table 2 presents the total costs of gliders operating in Europe for the years under study, distinguishing investments from running costs. Investments grow each year, which displays the willing of institutes to use gliders increasingly as an oceanic platform for data collection. Consequently running cost for maintenance and people also increases. Figures 5-7 indicate the total spent by institution for each year, along with the number of gliders owned.

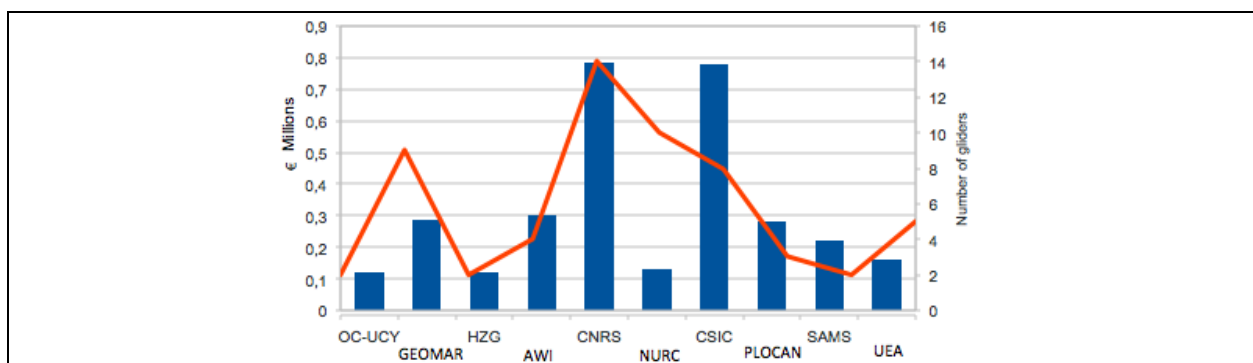


Figure 5: Total spent 2011. In red, the number of gliders owned by each partner

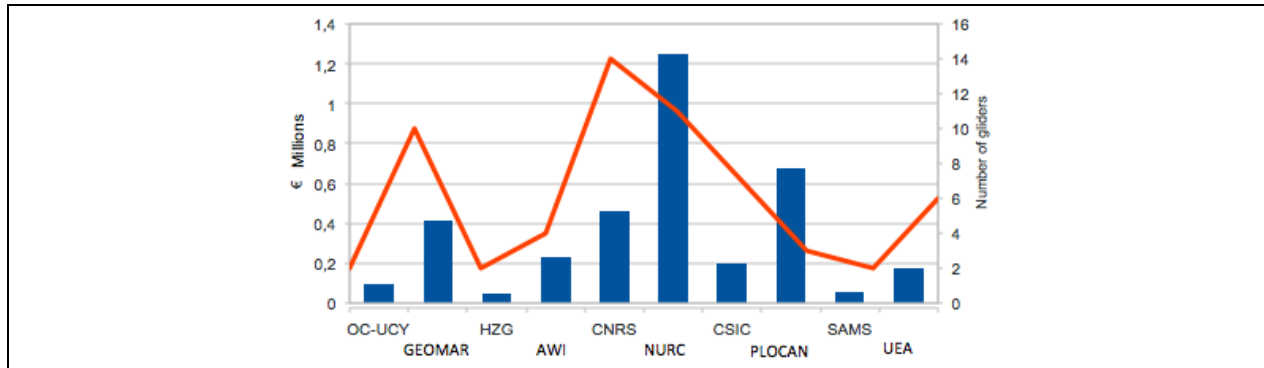


Figure 6: Total spent 2012

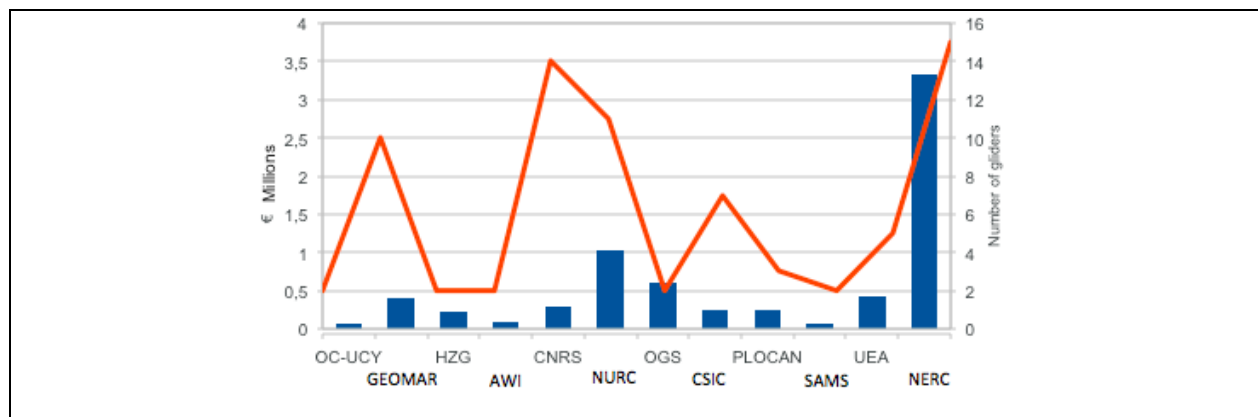


Figure 7: Total spent 2013

For 2011 and 2012, there is a correlation between the number of gliders owned and expenditures. Interannual changes are due to glider purchase. In 2013, those institutes do not need to buy more gliders, so the expenditures are less. OGS and NERC did not operate gliders in 2011 and 2012 and salary cost information from HZG, SAMS and UEA were missing for 2011. Total spent for OC-UCY, AWI and CMRE were extracted from the JERICO survey for the year 2011. Over the last 3 years, NERC, CMRE, CNRS, CSIC are the institutes that have invested the most in gliders. Money spent on investment and operating as a relative fraction by partner is shown in figs. 8 and 9, respectively.

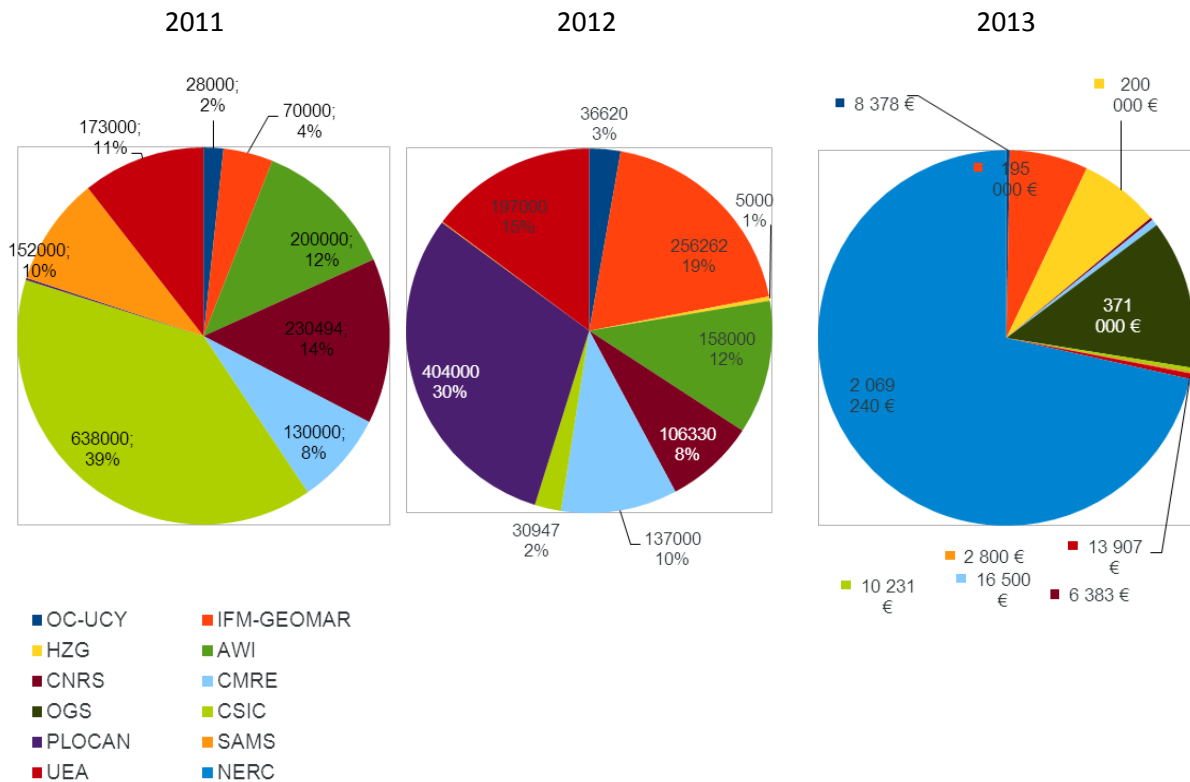


Figure 8: Investments (euros) for each partner operating gliders

Institutes invest alternately in gliders. It is logical that those who invest in 2011 and/or 2012 will not purchase equipment in 2013. A domino effect can be seen, indeed once one or two labs have their own gliders, others followed suit.

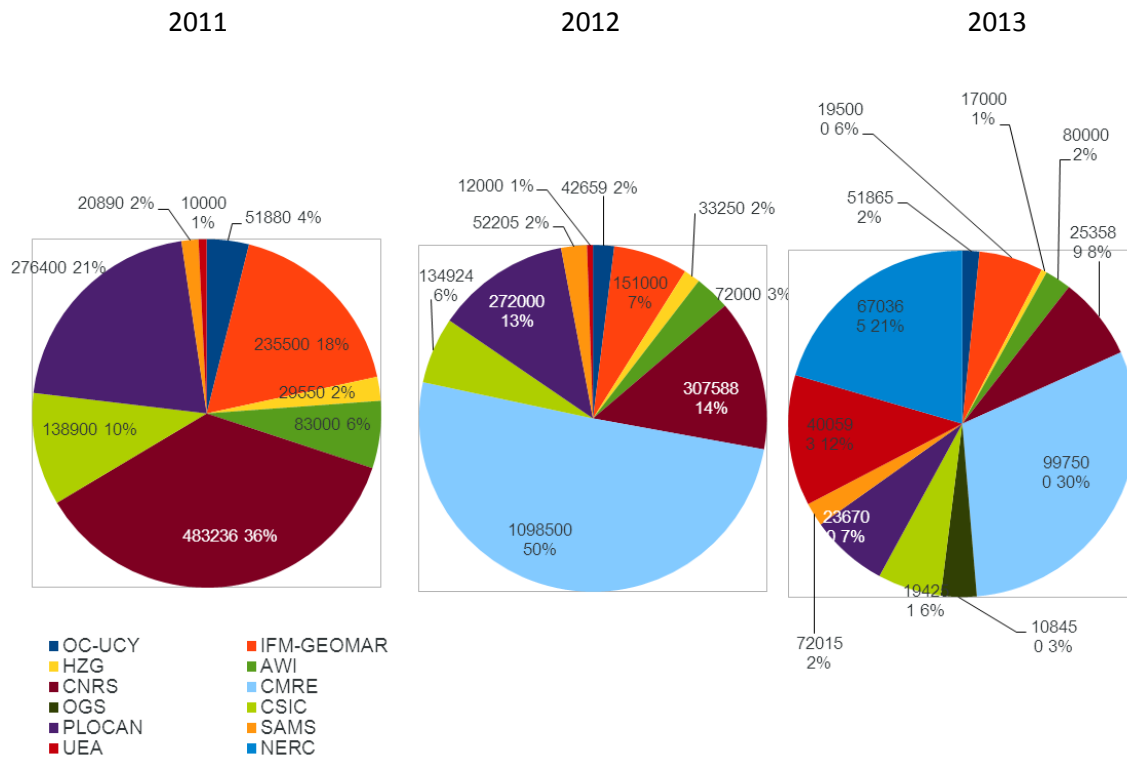


Figure 9: Running costs for each partner operating gliders

Interannual changes for running costs might be explained by the number of research projects in each institute. Indeed people are often recruited and money is spent to accomplish missions.

The categories of investments is further broken down and shown in fig. 10.

2011

2012

2013

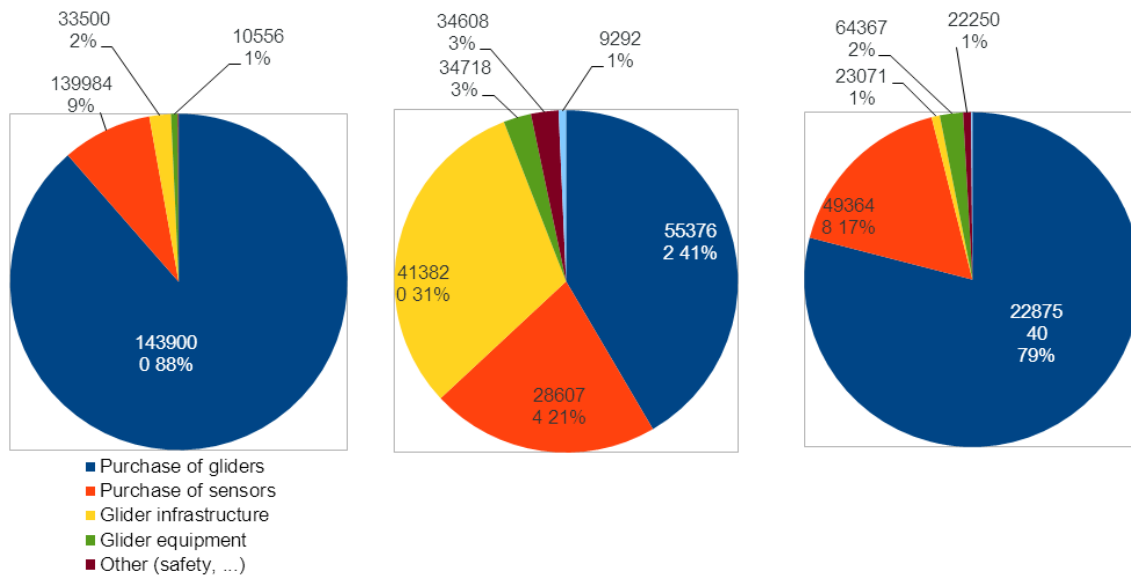


Figure 10: Total distribution of investments

Without surprise, the main investment is the purchase of gliders in any year. Possibly, in the future, once all institutes would have their own gliders, the part of the purchase of gliders in investment would decrease drastically. On the other hand, it is not certain how many years will pass before the European fleet reaches a plateau. Nor does anyone know the average lifetime of a glider in order to calculate the continuing investment required to maintain that fleet.

In a similar fashion, the distribution of running costs has been broken down to a detailed level (fig. 11).

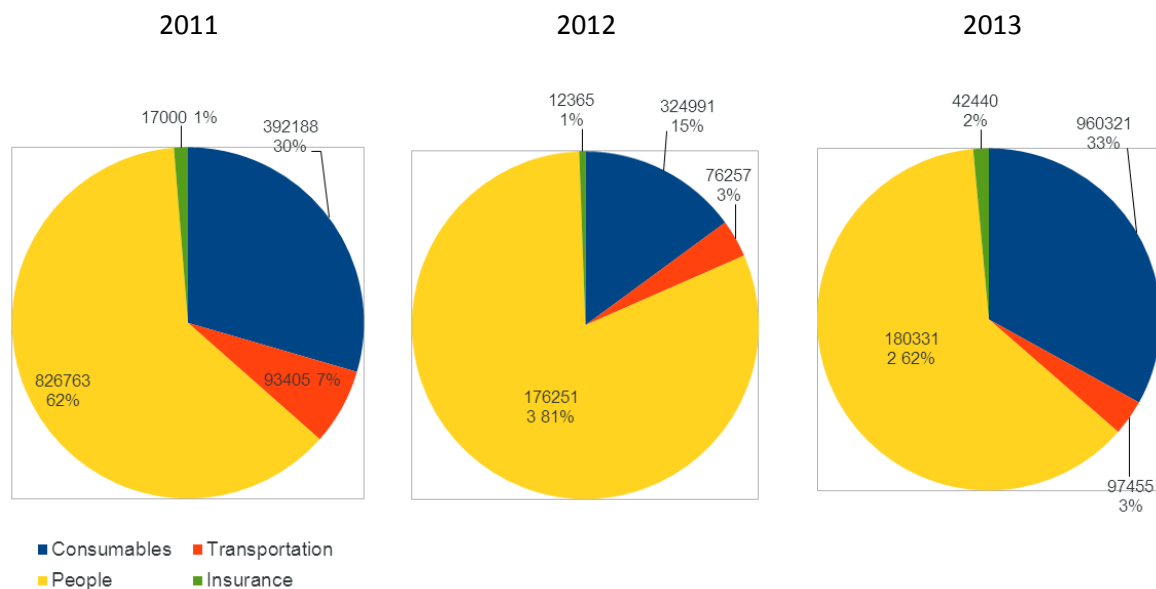


Figure 11: Total distribution of running cost

Salaries of people represent a very large part of the running cost. It is a consequence of the purchase of gliders and equipment. Institutes need more and more people to manage fleets and missions and therefore it increases the running cost year by year. Because consumables include a wide variety of expenses, it has been further broken down by type (fig. 12).

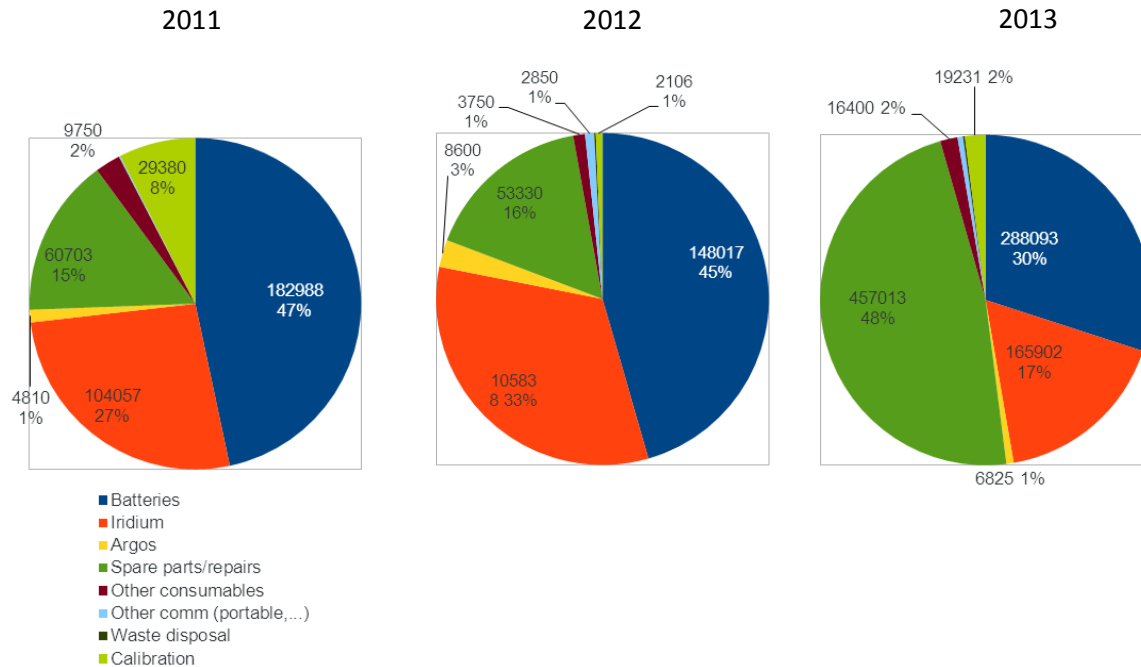


Figure 12: Total distribution of consumables

The cost of batteries is one of the most significant of the consumable section. It increases due to the number of gliders in Europe. Costs for spare parts and repairs also increase a consequence of the purchase of gliders and equipment.

It is also useful to further analyze people costs, because an unknown mix of permanent and contracted personnel with a variety of expertise (science, engineering, information technology, and administration) is present in Europe. Permanent and contracted people represent roughly the same part of people cost (fig. 13). It also seems that at most institutes, the demand for technicians is typically higher, followed by a mandatory scientist or two, and optional or merged positions of IT and Engineering. Interpretation is made difficult by the fact that numbers of staff are low and often merged among glider-related roles, as well as among other projects/roles. It is common, for example, for a glider-scientist to act as a glider-technician for part of their time, but to be active in non-glider projects for the rest of their time.

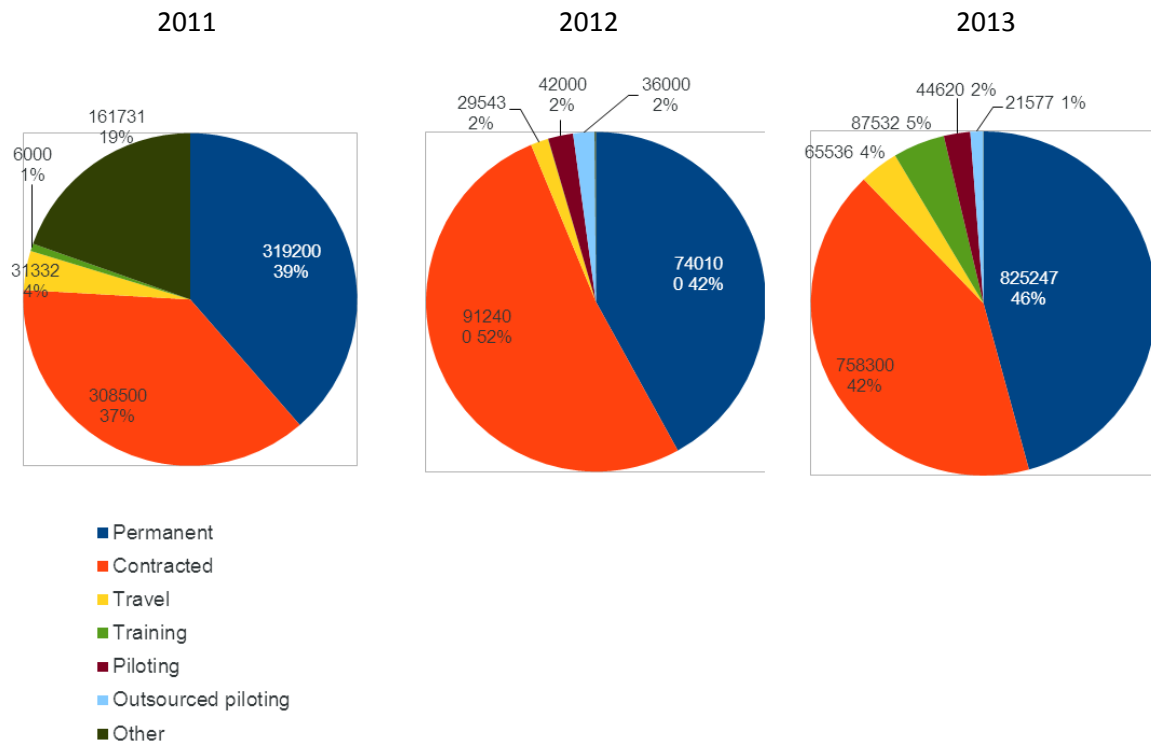
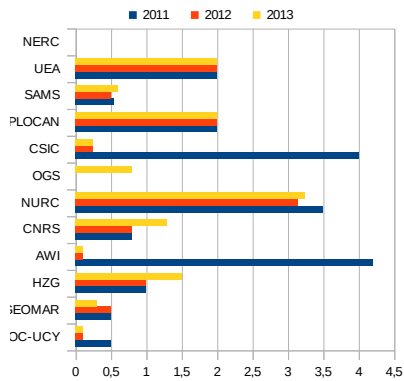
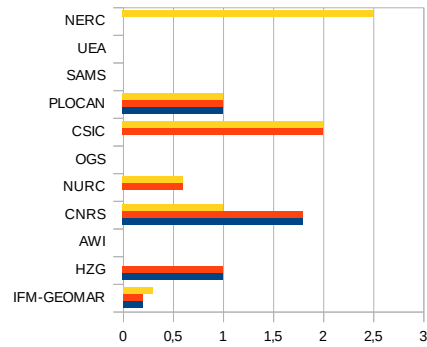


Figure 13: Total distribution of people cost

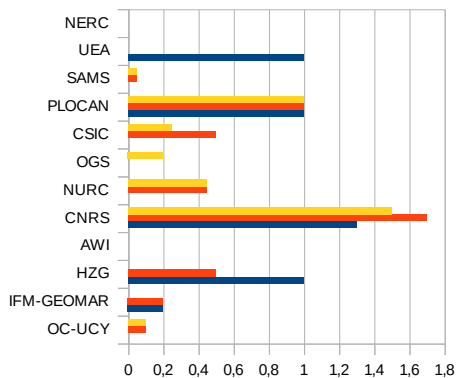
Technicians



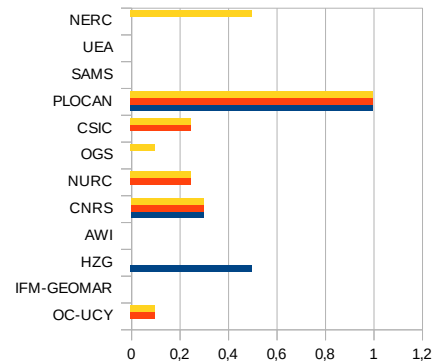
Engineers



IT



Management



Scientists

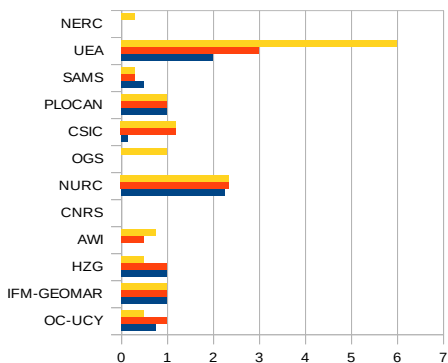


Figure 14: Human resources

III. Estimated costs

Now that the distribution of historical expenses has been described, in this section, we estimate the costs to setup and operate a glider infrastructure. Relying on the reported costs, we will then consider:

- What is essential to deploy a glider,
- What would be very useful to have (intensive use of gliders).

In order to have a better idea of what an infrastructure to operate a glider looks like, and before going into details, here are the main components for deployment and utilization of these oceanic platforms. For a more detailed description of the glider infrastructures used in Europe, please see D5.1.

3.1 Cost to build infrastructure

3.1.1 Building

Current glider ports are already integrated into institutes or laboratories. They use local resources: people, offices, internet, electricity, water, room for storage, room for labs. Sometimes, building works were made to fit out a laboratory for the glider activity. For example:

2009: CNRS lab 19k€ (surface 25m², air conditioning 2170€, electrical work 4721€, stonework 10900€, compressed air 1310€)

2010: PLOCAN lab 50k€

Essential: Works to make a lab dedicated to glider activity 50 k€

3.1.2 Equipment

Ballast tank

A tank is often used to ballast the gliders. Some partners use local resources (pool). Otherwise they have to buy a tank:

2010: 5000 € (HZG)

2013: 2500 € (OGS)

Essential: 5k€

Iridium phone

For a deployment or a recovery, communication between a pilot at land and the person who is deploying the glider is mandatory. So for the area not covered by cell phones, an Iridium phone is required.

Enhanced: 1 k€ for the Iridium phone (and prepaid simcard)

Crane or gantry

This is used to move the gliders in the lab

2011: 5 k€ CNRS (for the glider lab, modification of the roof and purchase of the crane)

2012: 4 k€ CMRE (for the ballast tank)

Essential: 5 k€

Tools

These are needed to work on the gliders (for repairs, for preparations)

Essential: 5 k€ (average of answers for partners having less than 5 gliders)

Enhanced: 10 k€ (mean done with partners having and more than 5 gliders)

Calibration facility

CMRE: They have a calibration facility for CTD and irradiance sensors. Furthermore they can validate calibration of Eco Pucks (optical backscatter and fluorescence sensors) and beam attenuation meter sensors.

The cost for the glider CTD calibration bath was approximately 50 k€; this infrastructure is used 80% for gliders. The cost for the optics calibration facility was approximately 120 k€; 50% this infrastructure is used for gliders.

50 k€ for CTD and irradiance sensors

120 k€ for optical sensors

HCMR : The calibration facilities at the HCMR Thalassocosmos complex in Crete include fully equipped laboratory with a special designed large calibration tank, two smaller glass tanks and a number of (secondary) reference sensors and equipment for temperature, salinity, chlorophyll-a, turbidity and dissolved oxygen sensors calibration. The support team consists of the HCMR technicians and scientists, who regularly prepare the instrumentation, perform field experiments, service and maintain the instruments and assist during the experiments in the calibration facility.

Setup cost: 250 k€

HZG: They typically calibrate the optical sensors and CTD in the field. They have built an aluminum frame (basically adapting an existing one, so the costs are presumably skewed). This frame takes two gliders and in the center it has a set of reference probes (that are easily calibrated in the lab or by the manufacturer) and a further 3 water samplers that can be used to get water samples at a specific depth and have it filtrated to get the sediment concentration of chlorophyll concentration.

150 k€ for CTD and optical sensors

OGS: The CTO (Centro di Taratura Oceanografico), as it is now, is the result of about 40 years of continuous investments. It is impossible to quantify the amount of money, time, building project, modifications of the existing structures, additional instrumentation for monitoring the electromagnetic pollution, the distribution of the electricity etc.

The actual instrumentations' value is more than 500 k€.

They also perform calibration for other lab: CTO has specific procedures for the calibration of the parameters of Temperature and Conductivity of almost all Sea Bird Electronics (SBE) instruments. For a CT calibration of a standard CTD (SBE16 or 19 for example) the CTO requests (as reimbursement) approximately 450 € + VAT

Miscellaneous

IFM-GEOMAR: Rollable workbenches 4k€

CMRE: workbench 2 k€, water filter for ballast tank 1 k€

CSIC: pressure chamber to detect any leakage in the glider assembly 39k€

Comment: When pressure chamber is owned, it is less necessary to make a test a sea with the glider. It allows to verify whether the glider leaks and therefore to save time.

Enhanced: Pressure chamber 39 k€

(Rubber) boat

This type of boat is used for the tests at sea, deployments (if possible) and recoveries (if possible). It should be rent if the use is from time to time.

PLOCAN: Boat 400 k€ (50 % use), rubber boat 90 k€ 300€/day

CSIC: Boat 354 k€ running cost 6k€/year

CNRS uses a rubber boat by IFREMER (56 k€)

Enhanced: 90 k€ for a rubber boat

3.1.3 Computing

Iridium setup

All the partners use the RUDICS setup for the main phone number of the glider calls. For the alternative phone number (the glider calls if it cannot reach the first one), the ratio is 50/50 for RUDICS/dial-up. The manufacturers can provide a free access to their dock server/base station.

Essential: 1 k€ for a RUDICS setup (main phone number)

Enhanced: 1 k€ for a second RUDICS setup (alternative phone number)

Each type of glider has to have its own RUDICS setup. If you own Slocum and Seaglider gliders and if you use RUDICS for the main and backup phone number, you will need four RUDICS access.

Data center (servers, computers, and software)

Most of the partners using gliders are hosted in university or laboratories, it is better to have the required servers used for the glider activity managed by the local IT team. So the servers (virtual machines if the local IT use virtualization technology) will be hosted in their computing room which have air conditioned and secure electrical power.

If local IT can only provide internet connectivity then the servers must be managed by the glider team (with minimal support from IT).

Dedicated servers with Linux operating system are required for:

1 - Communications: This server is critical; it is the link with the gliders. It must be redundant. If it has problems, it must be replaced quickly.

It could be two reliable desktops or two rack servers installed in a computing room (in 2 separate locations, to protect the system in case of emergency and with air conditioning and uninterruptible power supply).

Essential: 4 (8) k€ for two (four) computers (four if two types of gliders to operate)

The Linux operating system is free of charge.

2 - Data processing: A reliable desktop used for every type of glider. It will be used to process the data sent by the gliders.

Essential: 4 k€ (2 k€ for a desktop, 4 k€ because of redundancy)

3 - Piloting: Manufacturers provide tools to pilot their gliders but they are not very friendly. A web server can be setup and software to be developed to better manage the gliders.

Enhanced: 4 k€ (2 k€ for a server, 4 k€ because of redundancy)

4 - File server to back up the data and systems

Essential: 4 k€ (2 k€ for a server, 4 k€ because of redundancy)

5 - Rugged laptop to prepare gliders, for the deployments, recoveries, tests at sea: 2 k€/laptop

Essential: 4 k€ (two laptops)

Software

MATLAB (500 € for a basic license) is required to tune the Seaglider and people may use it for data processing.

Essential: 1 k€ for two licenses

3.1.4 Conclusion

Table 3 shows that one needs to invest a minimum of about 100 k€ to build the glider infrastructure. If a pressure chamber and a calibration facility are desired, 180k€ must be added.

Type	Essential (k€)	Enhanced(k€)	Sub -Total (k€)
Building	50		50
Equipment (tools, ...)	21	30	51
Calibration facility		150	150
Rubber boat		100	
Computing	18(22)	4	22(26)
Total (k€)	89(93)	284	373(227)

Table 3: Summary of the investment costs to build the infrastructure (in parenthesis, if two types of glider are expected).

3.2 Costs to operate the infrastructure

Once the infrastructure is set up, it must be maintained and operated. The costs below are estimates based on respondents to the survey, and vary widely by the type of usage and model of glider port (see D5.1).

3.2.1 Building running costs

This concerns the infrastructure costs (hire of premises, phone, heating, maintenance, internet access) for the offices, the glider lab and the storage room.

The running building costs due to glider activity is often integrated within the whole institute running costs, and it is difficult to estimate.

CNRS: 70 m², 80€/m²/year: 6 k€

PLOCAN: 40 k€ (2011), 12 k€ (2012) and 12 k€ (2013)

CSIC: 29 k€ (2011), 39 k€ (2012), 51 k€ (2013)

AWI: 30 k€/year

The given values for those institutes must be used with caution. The partners who gave a cost for this task, did not necessarily take in account the same things to estimate the building running cost.

3.2.2 Calibration facility

CMR: 11 k€/year

HCMR: 12 k€/year

OGS: For the 2015 they allocated about 60-100 k€ for the instrument renewal, alignment of the reference instruments, material for the calibration. It is also important to consider the unexpected events and the maintenance (and cleaning) of the structure/office/lab.

Enhanced: 15 k€

3.2.3 Staff

Administrative people to manage billing, travels, purchase orders: 30 % FTE (fig. 14)

IT people: 1 FTE the first year to setup the computing infrastructure then 30 % FTE if the servers are managed by the IT or to develop software or negligible if the glider team manages itself its computing. This number can be more important if many software developments are needed (CNRS).

Essential: 30 % FTE for management

Enhanced: 30 % FTE for IT

Example: Costs for CNRS (permanent staff)

-1 FTE engineer 51 k€/year (Essential = 13 k€)

-1 FTE management/technician 43 k€/year (Enhanced = 16 k€)

3.3 Cost of gliders and sensors

When a glider is purchased, common sensors are included: The CTD, oxygen and the optical sensors. As a rough estimate, we add 10 k€ for an additional sensor.

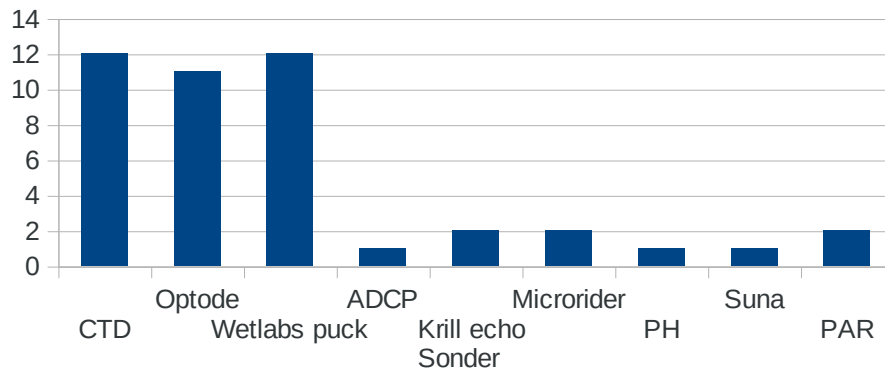


Figure 15: Sensors used by partners

Essential: Between 150 and 130 k€ (the average cost of a glider with CTD, O2 and optical triplet)

Enhanced: G gliders, $G \cdot 130$ k€ ($G \geq 1$)

Enhanced: 10 k€/sensor

Type	Essential (k€)	Enhanced(k€)	Total (k€)
Glider(s) with sensors	130	$130 \cdot G$	$130 \cdot (G+1)$
Sensors		$10 \cdot S$	$10 \cdot S$
Training	10		10
Total (k€)	140	$130 \cdot G + 10 \cdot S$	$140 + 130 \cdot G + 10 \cdot S$

Table 4: Investments related to gliders. G is a number of gliders and S in a number of sensors

3.4 Costs to operate gliders

3.4.1 Batteries

Slocum: Most of the partners having Slocum gliders change themselves the batteries, prepare and ballast the gliders. For example, the cost of a lithium pack for CNRS is 2.6 k€ and for HZG 3.5 k€ and it is used for one mission. The battery cost per day is computed by dividing the battery annual cost by the number of days of glider at sea and for partner changing themselves the batteries (IFM-GEOMAR, HZG, CNRS, CSIC, PLOCAN, UEA since 2012, and NERC).

Essential: 140 €/day/glider

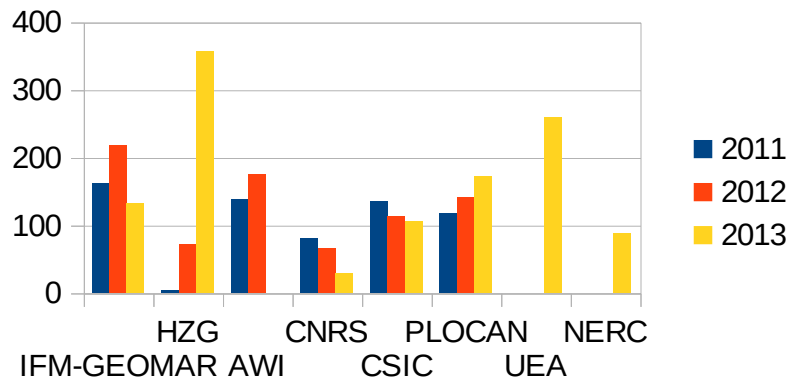


Figure 16: Battery cost per day (€)

Refurbishment for Seagliders (and Slocum):

Most of the partners that own Seagliders (CNRS, OC-UCY, SAMS, AWI, and UEA before 2012) send them to the manufacturer for a refurbishment (new batteries, repairs, calibration of the sensors, ballasting).

Enhanced: 15 k€ (cost of a Seaglider refurbishment)

Because of batteries, a waste disposal is needed:

2011 CNRS 608 €

2012 CMRE 500 €, CNRS 620 €

2013 CMRE 500 €, CNRS 880 €

Essential: 1 k€/year

3.4.2 Communications

The Iridium cost per day is computed by dividing the annual cost by the number of days of glider is at sea for both Slocum and Seaglider gliders.

Essential: Average: 75 €/day (between 80 €/day and 47 €/day)

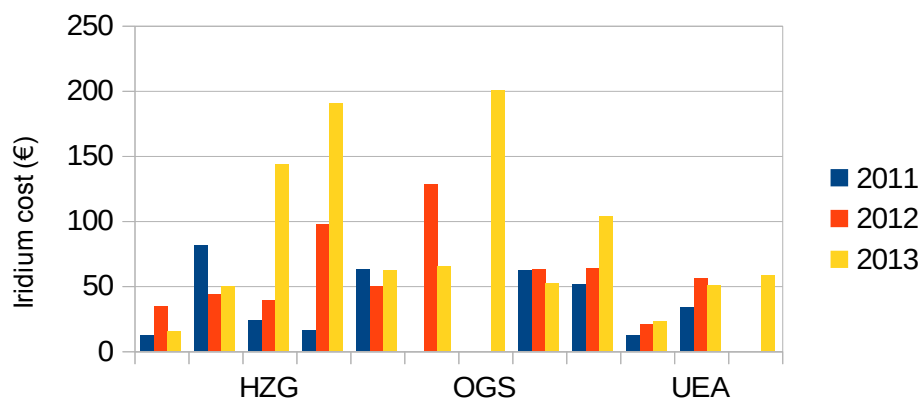


Figure 17: Iridium cost per day

Use of the site of manufacturer for the Iridium backup: No cost.

Argos tracking service: Cost about 40 \$/month/glider

Essential: 1 €/day/glider

Cell phone:

Essential: 40 €/month for 2 cell phones (CNRS)

SMS: To send alarms to pilots

CNRS: ~ 6000 SMS/year

Essential: 600 €/year (0.1 €/SMS)

3.4.3 Maintenance

Gliders

CNRS: 1 maintenance: ~ 5k€ (shipping and repair)

Essential: 5 k€/year/glider

Sensors

CNRS: 1 calibration/year/sensor, 2 k€/sensor (with shipping)

Essential: 2 k€/sensor/year of use

Rubber boat

Enhanced: 2 k€

3.4.4 Staff

Local human resources: Permanent cost

Head Engineer: To manage the glider pool

Essential: 1 FTE. Fifty percent of his time to manage and 50% to help the glider operations.

Technicians:

Essential: 1 FTE

Enhanced: 1 additional FTE (If many gliders to operate)

Note: If the glider is refurbished by the manufacturer, then there is less preparation and 1 technician should be enough (0.5 technician).

IT: To maintain the computers used for the glider infrastructure

Enhanced: 30 %

Scientists: To define the missions, data processing (Fig. 14)

Essential: 1 FTE

Example: Costs for CNRS (permanent people)

- 1 FTE engineer 51 k€/year

- 1 FTE technician 43 k€/year

- 1 scientist CR2 51 k€/year

Essential: 1 FTE engineer + 1 scientist + 1 technician = 145 k€/year

Enhanced: 1 technician + 30 % FTE IT = 59 k€/year

3.4.5 Piloting

Piloting 24/24 and 7/7 is paid or time off is given. Some partners can use students for 24/24 and 7/7 piloting on a voluntary bases.

CNRS 2011 and 2012: 25 k€

Essential: 25 k€

Enhanced: Outsourced (AWI: 36k€ in 2012, 21 k€ in 2013; UIB: 40 k€ in 2012)

3.4.6 Training

It is critical that technicians and engineers, and in some cases scientists learn how to prepare and pilot the glider.

Essential: 10 k€/person/type of glider (including travel expenses to manufacturer headquarter)

3.4.7 Insurance

CSIC, PLOCAN and UEA use insurance for glider loss: 12 k€/glider/year.

Enhanced: 12 k€/glider/year

3.4.8 Deployment and recovery

Gliders should be tested before to be sent to the mission place, especially if it has to be deployed far from the glider facility. Partners nearby the sea can make sea trials but this requires the use of a boat. Before 2013, CNRS typically rented a rubber boat with a pilot for 1 k€ for each sea trip.

Enhanced: 1 k€/test

The transportation of the glider to the mission area can be done using:

- Van rental and someone from the glider team (add travel expenses) if possible,
- Shipping, sea road or airline.

NB: Shipping by plane of lithium batteries is quite difficult because of safety protocols.

It is important to distinguish coastal deployments from deployments in the open sea which are more expensive since they require ships and transportation of the glider. Travel expenses may also be expected.

Examples:

- Local location: The glider port of the partner CNRS is based at Toulon at the seaside. The deployment for an endurance line is at 5 km from the coast. A rubber boat was rent for tests and for the deployment, the cost was 1 k€ per day. There are no travel expenses.

Essential: 1 k€

- Remote location: IFM-GEOMAR deployed several gliders already ballasted in Cape Verde. The cost for transportation (sea shipping) for 1 or 2 gliders is 3 k€.
- To reach the deployment area, there are several options:
 - A big research vessel is often there for the process studies, no cost,
 - A local 25m research vessel is available at 4000-5000 € per day,
 - Recreational fishing boats go out at sea at about 800 € per day.

Which one is used depends on the deployment location and deployment goal. The small boats do not venture too far from shore (within sight, i.e. 5-10nm) and the weather has to be ok for them. Winter sometimes requires one or even two weeks of waiting (even for the 25m vessel).

Concerning the travel expenses, 10 days would be around 1500-2000 € for one person (800€-1000€ for the flight, 80 € per night in hotel, 80 € as per diem). Depending on the number of gliders (1 to 6) 2 to 4 people would go and often do the ballasting on-site at the local institute. If the gliders are ballasted and there are experienced local people, one person might be enough.

Essential: For one glider deployed, 3000 € (transportation) + 800 € (to deployment location) + 800 € (flight) + 7*(80+80) (7 days for a person of the team) so approximately 6 k€

As for the deployment, the cost to recover the glider depends on the place where it was deployed. It may require:

- The use of a ship (rental or not),
- The transportation to the institute (+ someone from the glider team then add travel expenses, conveyor),
- If someone of the glider team is needed, add travel expenses.

Essential:

- Local: The recovery is usually near the cost, rent a boat: 1 k€
- Remote: It should be done by a local contact so it should be the cost of renting of ship to go the recovery location (800 €) and the transportation back to the institute (3 k€), so it should be approximately 4 k€.

3.4.9 Depreciation

The depreciation of the equipment (gliders with sensors) is expected after 5 years of use.

Essential: $130/5 = 26$ k€/year for one glider

Enhanced: $N \cdot 26$ k€/year for N gliders

The depreciation for the computers is often expected after 3 years.

Essential: $16/3 = 5.3$ k€/year

Enhanced: $4/3 = 1.3$ k€/year

The boat depreciation is estimated according to the CNRS at 25 years.

IV. Mission costs

In this section, we identify all the steps to deploy a glider and then consider the possible scenarios to operate them and the associated costs. Please see D5.3 for recommended operating procedures in detail. This section is intended to explore in more detail how the costs vary according to the type and intensity of glide operations

4.1 Steps

They are 5 main steps for a glider deployment. It is listed here then detailed later in the text:

- 1- Preparation of the mission
- 2- Test of the glider
- 3- Shipping
- 4- Deployment (with piloting)
- 5- Emergency Recovery

4.1.1 Preparation of the mission

The glider must be prepared before any deployment. The glider itself is rehabilitated (new pack of batteries, ballasting, magnetic compass recalibrated, spares etc.) and the sensors may need to be recalibrated (The glider and sensors maintenance is done at the same time as the preparation).

Here, three possibilities are available to users.

- (1) The lab sends everything to the manufacturer for the preparation (glider + sensors),
- (2) The institute/lab who wants to deploy the glider does the all preparation itself (glider + sensors: it requires 2 technicians during 1 week and the time preparation is independent from the mission time),
- (3) The lab prepares only the glider and sends the sensor in otherlab for calibration.

It is summarized in the scheme below.

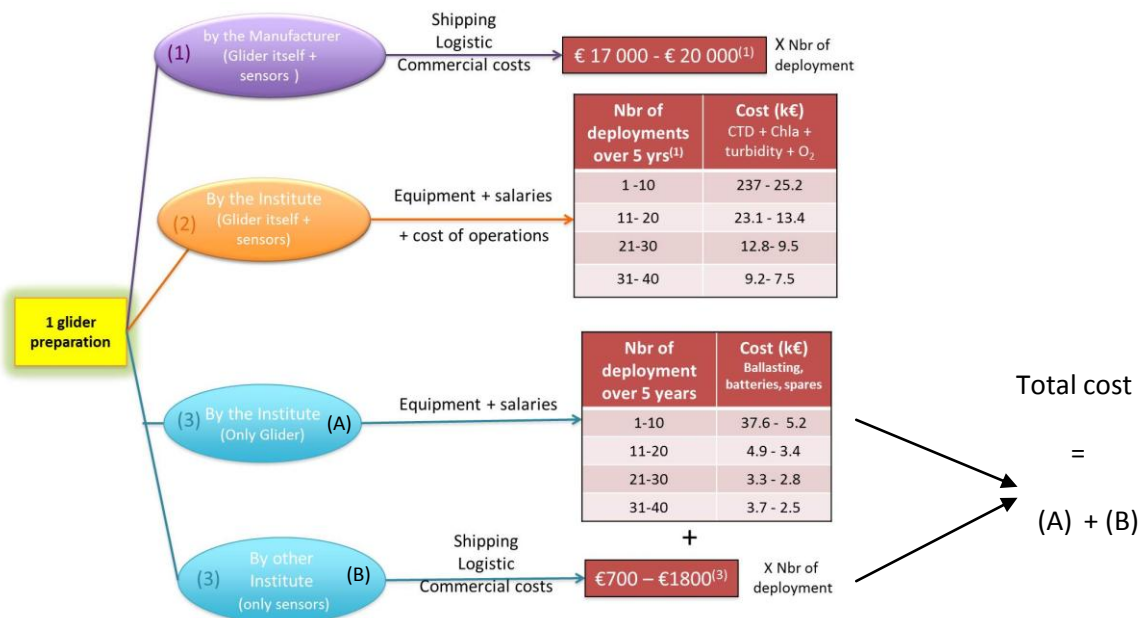


Figure 18: Cost of a glider preparation

The expected cost of each is as follows:

(1) Varies according to the spares and the number and the type of the sensors, which need to be recalibrated.

(2) The cost of local preparation (by the institute/lab) depends on – (a): the equipment's lifetime which have been bought to operate these gliders, (b) – the cost of training to learn how to prepare and pilot the glider (10k€/person/type of glider) and – (c): the number of accomplished deployment. Indeed, longer is the lifetime; more the equipment provides a return on investment. It is quite difficult to estimate it, therefore we will take arbitrarily 5 years, the given time by the CNRS after it is recommended to change an equipment when it costs more than 800 €.

This estimation has been made from institutes that have invested in calibration facilities. The average is 200 k€ (cf. 3.1.2, OGS was not taken in account because of the 40 years of continuous investment and not just for glider operation) to calibrate sensors indicated in the table.

Here is an example to illustrate the table: If the institute wants to do 10 deployments over 5 years, the cost of a glider preparation would be: $(200 \text{ k€} + 16 \text{ k€} + 10 \text{ k€} \times 2) / 10 + 1.6 \text{ k€} = 25.2 \text{ k€}$.

200 k€ being the cost of calibration facilities, 16 k€ the cost of equipment for the glider (tank, crane, tools, workbenches), 10 k€ the cost of the training (x2 because 2 technicians) and 1.65 k€ the cost of 2 technicians salaries during 1 week(cf. 3.2.3).

We notice that the cost of preparation per mission decreases with the number of deployment accomplished (over 5 years) and depends on the initial investment for calibration facility. Thereby, the balance with the shipment of the glider the manufacturer is reached between the 13th and the 15th mission.

Although it is quite difficult to estimate the cost of it, (so not taken into account here), it is good to know that each time a glider is involved in a mission, that a scientist took time to establish a research project. A report is written to present and explains what is the aim of it; and then submitted to different funding agencies for the research; or eventually to industrials to receive money.

(3) – For the third way to prepare a glider, the reasoning is the same as before, but only the cost of the training and the cost of the glider equipment are considered: 10 k€, 16 k€ and 2 technicians salaries during 1 week.i.e. for 10 deployments, each of it will cost: $(16 \text{ k€} + 10 \text{ k€} \times 2)/10 + 1.6 \text{ k€} = 5.2 \text{ k€}$. The final cost is the glider preparation (A) + the calibration cost (B).

According to the questionnaire, only the OGS performs calibration for other lab.

4.1.2 Test of the glider

Once the glider is technically ready, it is tested, either at sea during 24-48 hours few kilometers off the coast, or in the laboratory.

The test allows to be sure that everything works properly before the long deployment in the open ocean. Here, we have two possibilities: (1) – at sea or (2) – in a pressure chamber.

(1) The test at sea is composed of 3 phases:

- a) Bring the glider to test place: It requires a rubber boat with a pilot and a technician on board and a glider pilot on shore.
- b) The deployment itself requires a pilot.
- c) The glider recovery requires the same staff as when you bring the glider.

The rubber boat is either bought or rented.

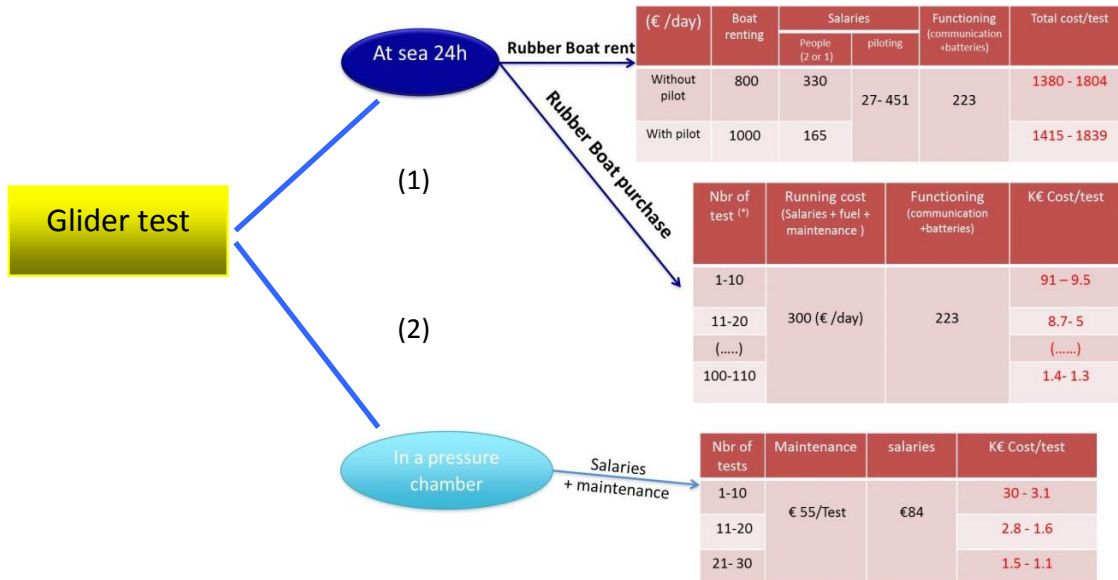


Figure 19: Cost of a glider test (The boat renting includes fuel)

Concerning the purchase of the rubber boat, according to the questionnaire, only PLOCAN has its own rubber boat. The running cost is not an average but the PLOCAN data.

(*) A test consists of 2 uses of the boat, a return trip (a half day each) between the spot of the test and the shore. The balance with a renting boat with pilot is reached around the 100th trial. The life time of a rubber boat is about 25 years, over this period; it makes 4 tests per year to have a return on investments.

Institutes	Cost (€/ Day at sea)
PLOCAN (2011-2012-2013)	27
NERC (2013)	60
CNRS (2011-2012)	40
UIB (2012)	100
AWI (2012-2013)	308
CMRE (2012 - 2013)	451

Table 5: Cost of piloting

When the staff pilots gliders, the cost is cheap, except for the CMRE. Indeed CMRE has two people monitoring the gliders permanently (24/7) during the experiments. Remain on standby duty at night and during the weekend might explain the cost. Regarding AWI and UIB, it is outsourced, therefore expensive.

(2) The cost of a pressure chamber is around 39 k€.The cost of one test has been estimated from the CSIC data, indeed they are the only one owning a pressure chamber in Europe (as far as we know). 600 € per year of maintenance and between 2011 and 2013 on average, 11 missions per year has been accomplished; it makes 54

€ per test. The test takes in total 3.5 hours on average: 2 hours from the technician in charge of the pressure chamber and 0.5 hour from one auxiliary technician. So two people involved in the test. The cost of 1 hour of work for a technician is estimated to 24 €. (for a CNRS technician, cf. 3.2.3)

The main steps of the test are:

- Glider and pressure chamber preparation (0.5h),
- Insertion of glider in the pressure chamber (0.25h),
- First phase of the test (1h),
- Second phase of the test (1h),
- Take out glider and cleaning (0.5h),
- Documentation (0.25h).

The return on investment compared with the in-situ test, is reached around the 21st use which makes about 4 deployments a year during 5 years.

4.1.3 Shipping (before launching and after recovery)

Intuitively, the cost for the shipping depends on the distance between the mission place and the gliderport. We have to distinguish shipping for coastal deployments and shipping for deployments in open sea which are more expensive since they require ships and sometimes transportation of the glider by plane. The table below shows the disparity between each mission. The variability of the shipping cost is due to the area of the mission (coastal deployment or in open sea deployment).

Transp/mission	2011	2012	2013	Mean
OC-UCY	1290	1086		1188 ^(*)
IFM-GEOMAR	1364	1250	444	1019
HZG		333		333
AWI	300	300	1000	533
CNRS	864	718	613	732
NURC	0	750	500	625
OGS			200	200
CSIC	154	222	360	245
PLOCAN	1000	583	583	722
SAMS	1280	2480	2170	1977 ^(*)
UEA			1323	1323
NERC			833	833
Mean	736	593	650	656

Table 6: Cost of transportation per mission

The mean 656 €/mission does not include partners with (*) who had shipping cost for refurbishment included in the shipping cost for mission.

4.1.4 Deployment

01/12/2014

GROOM website address <http://www.groom-fp7.eu>

As for the glider test, the cost of a deployment is shared between the communication, the piloting, and the people needed to launch and recover the glider.

Launching/recovery:

	Launching/recovery (1 day each)			
	Rubber boat		Boat (25m)	Lent boat ^(*)
Renting boat/ day (€)	Without pilot	With Pilot	-	-
	800	1000	4000 – 5000	0
Salaries (€)	2 people: 330	1 person: 165	165	0 – 330
Total (€)	1130	1165	4165 - 5165	0 – 330

Table 7: Cost of launching/recovery of a glider

(*) Sometimes, it is possible to join a campaign already scheduled and to board the ship for free. Another solution would be to prepare on board the glider before departure, and install it in a way that it is very easy to launch in water for someone outside the glider team when the boat reaches the spot. Like this no technician is required on the boat to do it.

As previously the wages represent 3 people when there is no pilot, and 2 people when the boat is hired with a pilot.

Mission

For the cost of the mission, we consider the cost of the glider (with sensors), the maintenance required to make it work properly, the communication, the computers for the communication, the batteries purchase and the cost of recycling, then the salaries for piloting.

		1 day mission (€)
Cost of glider (depreciation)		72 - 82
Computing (depreciation)		16
Sub-total equipment depreciation		88 – 98
Maintenance	Glider	13
	Sensors	17
Sub-total Maintenance		30
Communication		50 - 87
Batteries	Purchase	140
	Waste disposal	2

Piloting	27 - 451
Insurance	(~ 33)
Sub- total	332 - 826
Overhead	10 - 25%
TOTAL	370 - 1037

Table 8: Cost of a one day mission

The cost of the glider with basic sensors is estimated according to the depreciation (expected after 5 years) and the cost of investment. Here: 130 k€/(365x5), cf.3.3 (or 150 k€ for a *Seaglider*).

For the maintenance cost, cf. 3.4.3.

"Computing" is composed of computers for communication, for data processing and servers to backup. Here 18 k€/(3x365),cf. 3.1.3.

The communication is provided by the Iridium system, Argos system, cell phones, and messages (sms). The range is due to the type of glider used (cf. 3.4.2)

4.1.5 Emergency recovery

This step is obviously the one that nobody hopes to do. There are many possible causes for any problem.such as "Buoyancy problem", "Battery failed", "lost communication", "problem with rubber, wings" etc.

There are 2 possibilities: either the problem occurs at the sea surface or in water/on sea bottom.

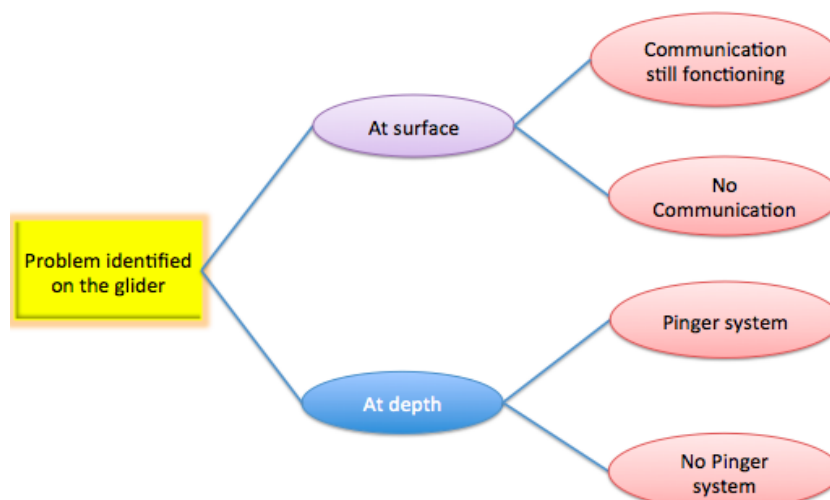


Figure 20: Circumstance of a glider breakdown

Intuitively, the recovery is much easier when the glider has come up to the surface and near the shore. If the communication system is still functioning, we know exactly where it is; if not, certain type of glider, as the *Slocum*, is equipped with the *Argos system* which allows localizing it 1km around (*Argos system* works independently from the rest of the electronic).

If the glider is totally mute, its position could eventually be deduced from its last position and the local current (if it is known but quite difficult). Then, according to the place where the glider is drifting/stuck, the recovery can be done by boat or by helicopter and costs up to several thousand euros.

	Cost (€)			
	By Fisherman	By Coast guard/Marine police/ Rescue Ship/Research Vessel (+ROV)	Boat renting	
			Rubber boat	Boat (25m)
Boat	0	0 – 8000/day (+NA)	800/day	4000-5000/day
Salaries^(*) /day	0	0	471 - 588	471
Rescue Helicopter	0 – 60/min			

Table 9: Cost of an emergency recovery

(*) For technician(s)

From time to time, fishermen recover the lost glider (randomly or not in nets) and sometimes negotiating is needful to have it back without paying. When the glider is close to the shore, a rubber boat is enough to get it back; otherwise a bigger ship is necessary. Some research vessel can recuperate the glider if they are on spot.

Although, the helicopter is very expensive, quite often, it is used to recover a glider in distress. As for the coast guard/rescue ship/marine police, sometimes there is no charge. Indeed, the navy/rescue helicopter takes it as a training and does it for free when it is not too far.

When the glider is stuck under water, it is much more complicated and expensive to retrieve. First of all, it must be localized. The *Seaglider* is equipped with a pinger, which allows to trace it. For other type of glider, the only solution is to use a sonar. It has not been done in Europe, but in USA *Seagliders* have been localized this way by the US Navy. Then a Remote Operated Vehicle (ROV) dives to get it back.

To be done, the cost of the emergency recovery must be cheaper than the cost of the glider.

4.2 Discussion

The choice of glider preparation must be made according to the number of planned deployments over five years. Indeed, the cost of calibration facility is very important. If this investment is made, the institute must be sure to do at least $\square 14$ deployments. Below this value, the refurbishment by the manufacturer is worthwhile (fig. 18, step 1).

The basic tools for a glider lab being not too expensive, the cheapest way to make the glider ready for the mission is to make it prepared by the institute and ask another lab already equipped for calibration sensors to do the calibration (fig. 18, step 3). From the 3rd mission there is a return on investment versus to refurbishment.

One assumption is that the life time of a glider and large equipment is five years. Although, gliders are used since 2004 in Europe, it is hard to stand back on this value. The life span may be greater, especially if strict protocol is implemented to avoid a quick deterioration of gliders and its equipment and therefore decrease the cost of using.

The purchase of a rubber boat just for the test has to be avoided (too expensive). On the other hand, if all deployments are scheduled near the coast and bringing and recovering the glider would be possible by rubber boat, then buying an inflatable boat may be worthwhile (especially if the boat is also used for other activities).

For one mission the boat would be used 4 times: twice for the test (a return trip), and twice again for the "real" deployment and the recovery. Knowing that a rubber boat costs $\square 90$ k€, it takes $\square 112$ uses (if we consider 800 € for the renting), to have a return on investment. If, for each mission, the boat is used 4 times, the balance with the rental is reached after $\square 28$ missions; i.e., 5.5 missions per year over 5 years.

NB: For a renting boat, gas and maintenance are included in the cost.

Concerning the deployment itself, the total cost range can be stated this way:

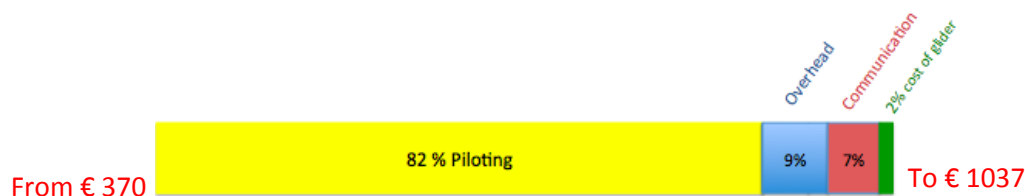


Figure 21: Range of one day mission cost

The cost of piloting depends exclusively on the salaries, and the type of person in charge of this task explains differences in wages (cf. Table 4). Indeed, according to the institute, it is either a PhD student, a post-doctoral, a technician, an engineer, or a researcher of the faculty responsible for it. Someone from outside, as for AWI, can also do it.

In order to reduce this expense drastically, a member of the staff must do the piloting and not outsourced. With the aim of a sustainability of the glider activity throughout Europe, people

must be trained, skilled and dedicated to this task. To go further, it would be even better if it was always the same person(s) in charge of piloting (and of the preparation of the glider), ideally, a technician or an engineer. It would allow the pilot to acquire experience year after year, to know perfectly their glider and therefore minimize the probability to have a break down due to "bad" piloting or preparation (almost 25% of failure missions are due to leaks, M.Brito et al., 2013). Consequently, it would lower the cost of the on-call system (at night and during the weekend), which makes the cost of piloting very high.

Concerning overhead costs, it is intrinsically linked to the institute/Lab in charge of the mission, so it is difficult to reduce costs on this part.

The communications cost depends on the type of glider. Indeed, the iridium cost for a *Seaglider* is 40% cheaper than for a *Slocum* (cf. 3.4.2). It might be explained by the time spent at the sea surface between the two models for communication with the satellite, and the volume of the transferred data.

Although, there can be a difference of 50 k€ in the purchase of a glider (according to the manufacturer, the type of installed sensors etc.), the price has only a little influence on the cost of a mission.

According to M. Brito et al (2013), there are at least eighteen problems identified to failure mission of a glider, and therefore to emergency recoveries. *Leak*, *Power/Battery failure* and *Buoyancy pump failure* represent almost 50 % of breakdown (fig. 22).

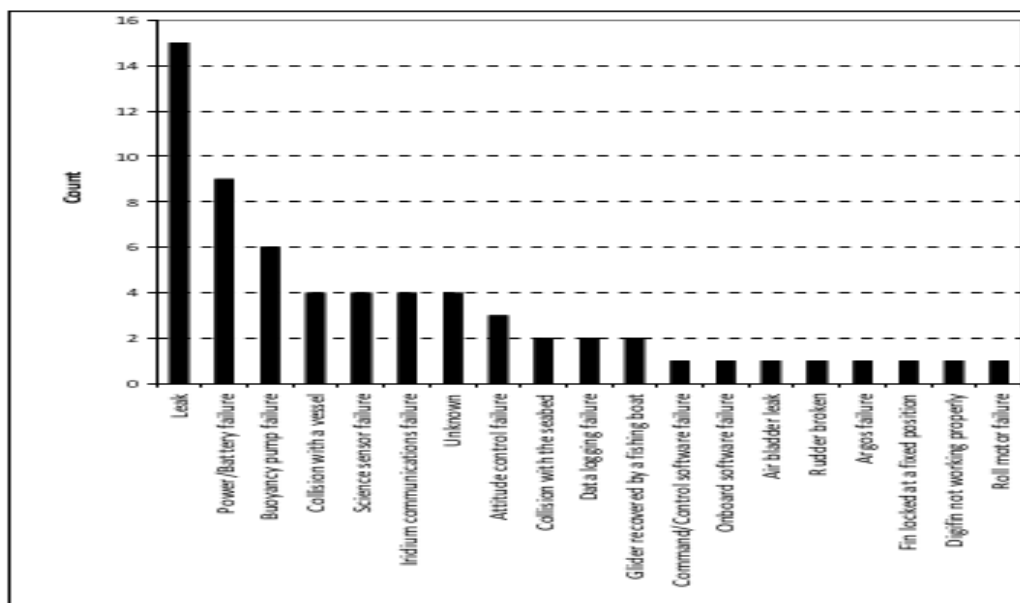


Figure 22: Failure modes for all undersea gliders, shallow and deep (M.Brito et al., 2013)

V. Conclusions

The respondents to the GROOM survey have provided a detailed look into the costs over the years 2011-2013. The twelve European partners operating gliders have a wide range of scientific and operational modes, so these historical costs represent a wide cross section of usage. Of course the results are to be considered a snapshot, and not a steady spending pattern that can be extrapolated into the future. However, it does allow a rough estimate of expected set up and running costs for those organizations wishing to begin or enhance glider activity. Besides institution-level planning, these costs also begin to describe the costs one might expect in a more coordinated European glider research infrastructure. The results of this study can help in the planning and organization, and ultimately, implementation, of a European glider infrastructure.

European Level

Although, Europe is facing an economic crisis since 2008, and the research institutes have seen the reduction of their budgets, invested money in glider activity is growing significantly. Between 2011 and 2013 the investments and the running cost of glider activities have increased of 57% and 41% respectively (Table 1). It clearly displays the awareness from the scientific community and the policy-makers of the capacity of gliders to accomplish difficult tasks and to fill gaps of oceanographic data. The will to go further in terms of organization and infrastructure of the glider activity within Europe is manifest and obvious for the different teams.

Even though the glider port and the organizational models have been described and discussed in detail in D5.1, it is important here to discuss further. Indeed, in the aim of minimizing cost, a European framework must be considered and not only the observatory infrastructure itself. Figure 4(from D5.1) summarizes what a glider port should look like. In that report, the idea of a set of distributed glider ports, each with their own contribution (set of puzzle pieces) is put forth as a likely extension of the current situation, but with the necessary centralized coordination to be added through a GERI: Glider European Research Infrastructure: "The role of the GERI should be to support and encourage the glider developments in Europe, by engaging its partners to share tools and experience, participate to good practices and standards definition when appropriate, and provide access to member gliders if they are available." The reason for this is to take advantage of the strengths and capabilities of the existing glider ports, but improve the networking and sharing of resources in order to streamline the work across Europe. This "unification" of knowledge, acquaintance, techniques and people would provide many advantages. Here, we examine some of the financial benefits to forming a more integrated glider research infrastructure.



Figure 23: Map of European glider infrastructure in 2013

The existing equipment in Europe is quite substantial but none of the glider ports implements all tasks. The idea would be to pool all tasks of fig. 4 in 2 or 3 (or more) gliderports for each task.

For example, concerning sensors, 1 or 2 calibration center(s) could be set up for all European glider users (and external users as well). First of all, it would reduce costs, since it would not be necessary to ship sensors, and in some cases entire gliders, to the U.S.A, but only within Europe. This should also save time because of the reduced shipping bureaucracy since customs and battery issues are more complicated when leaving the European Union. Finally, the centralized calibration center(s) would enhance data quality by removing the above current obstacles to frequent calibration. Indeed, having the same calibration procedure (Same techniques, same equipment, etc.) improves the ability to make data comparisons. OGS (with CMRE) seems to be the ideal candidate to be the first European calibration center (cf. 3.1.2). Indeed, they already perform calibration for other institutes.

Similarly, regional glider ports could also make sense. It is cost effective to concentrate certain activities like refurbishment, piloting, and data processing in a few existing centers according to their expertise, instead of everywhere in Europe with highly experienced and trained teams, e.g. two or three bases in the northern Europe (around Baltic sea and North Western Shelves area) and two or three in southern Europe (around the Mediterranean Sea and Iberian Biscay Irish area).

For gliders themselves, the sharing and optimization of existing gliders must be considered. In 2013, Europe owned 84 gliders. According to www.ego-network.org, which shows the number of gliders in water, only few of them were active. (5 or 6 per month, also in 2014). The totality of the European fleet is far from complete utilization. Therefore, for the next years, it seems

useless to buy new gliders. Effort and money should be spent in developing the aspects of the glider network such as:

- Recruiting and training technicians, engineers, scientists, (In the JERICO report, the limited human resources to manage the existing fleet was also mentioned)
- Developing common software tools,
- Developing calibration facilities,
- Improving communication among gliderports,
- Homogenizing data processing and assembly,
- Sharing maintenance and deployment/recovery tasks,
- Sharing the gliders themselves (The service could be based on the Trans National Access (TNA) already existing).

If the GERI were to develop a protocol to prepare, use, store and refurbish it, it should be possible to extend the lifetime of these platforms. Indeed, all the costs in this deliverable are based on a five years life span. This period is a theoretical value, and gliders could last much longer. It would definitely lower the cost of use. For instance, GEOMAR owns and uses the same glider (Deepy) for 10 years. Through this protocol, longer deployments could be fostered, minimizing down time for refurbishment and testing.

Institution Level

The present study also provides useful information for institutes/lab who want to invest in gliders independently. It should be kept in mind, however, that many of the costs can be minimized by taking part in the GERI described above and in D5.1. Firstly, it is essential to forecast how many deployments will be done over five years and where. Accordingly, a strategy has to be devised in order to choose the equipment to buy and the most cost-effective way to prepare and use the glider. Some conclusions from the study:

- If possible, it is better not to outsource piloting (Table 5),
- The building being the most expensive part of a glider port, it is better to use/to restore an existing building to implement the observatory, instead of building a new one.
- For the deployment, the cost may be increased more than twofold because of the outsourced piloting. This is another reason for training and recruiting people within institutes dedicated to this task.



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Appendix: Cost survey – GROOM

FP7 GROOM project WP 5.4

Welcome to this GROOM questionnaire regarding costs.

This questionnaire will help us to determine how much it cost to have glider and how much it cost to fly gliders.

Eligible : The work and money spent to own and fly glider including TNA from European projects

Non eligible : the work and money spent on projects like GROOM, JERICO, PERSEUS, ...

On this page you can find a pdf version of the questionnaire to find all the answers being offline

The Jerico questionnaire on cost has already been filled by many institutions, To avoid multiple work, the layout of this questionnaire is very similar so:

If you already filled the Jerico questionnaire, this document shows you the questions you will have to answer ([jericoFilled.pdf](#))

If you did not filled the Jerico questionnaire, this document shows you the questions you will have to answer ([jericoNotFilled.pdf](#))

Thanks you for your contribution.

Elodie Godinho / Karim Bernardet

If there is any problem or if some questions are unclear, please contact :
karim.bernardet@dt.insu.cnrs.fr

There are 45 questions in this survey

1 - Identification

Please write your answer(s) here:

- First name
- Last name

2 - Name of your institution

Please choose **only one** of the following:

- UPMC | France
- OC-UCY | Cyprus
- IFM-GEOMAR | Germany
- ...

01/12/2014

GROOM website address <http://www.groom-fp7.eu>

3 - Did you fill the JERICO survey?

Please choose **only one** of the following:

- Yes and you can use the information I provided on Jerico survey
- Yes but I do not want you to use this information, I will fill in the information again
- No

4 - Do you want to fill the questionnaire for the year 2010 ?

Please choose **only one** of the following:

- Yes
- No

5 - Do you want to fill the questionnaire for the year 2011 ?

Please choose **only one** of the following:

- Yes
- No

6 - Do you want to fill the questionnaire for the year 2012 ?

Please choose **only one** of the following:

- Yes
- No

7 - How did you set up your iridium communications?

Please choose the appropriate response for each item:

Rudics Dial-up Both Not configured

Slocum primary

SeaGlider primary

8 - Did you set up your own secondary line?

Please choose the appropriate response for each item:

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Rudics Dial-up Both Not configured

Slocum alternative

SeaGlider alternative

Questionnaire for 2010

9 - Before 01/01/2010: Did you buy a special infrastructure (e.g. Pressure chamber) for glider use?

	Name of the infrastructure	Cost	% of use for glider application	Year of purchase
1				
2				
3				
...				

10 - List all the gliders you had on the 01/01/2010

	Glider name	Cost	Year of purchase
1			
2			
3			
...			

11 - Year 2010. How many gliders did you buy?

	Glider name	Cost
1		

01/12/2014

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Glider name Cost

2

3

...

12 - Please detail any infrastructure bought in 2010

name of the infrastructure cost % of use for glider application

1

2

3

...

13 - How many missions at sea did you accomplish?

Please write your answer here:

14 - How many days at sea did you accomplish?

Please write your answer here:

15 - How many full time equivalents from your institution were working with gliders

Please write your answer(s) here:

- Scientist
- Technician
- Engineer
- IT
- Management
- Other

16 - What is the annual operating budget of your facility in 2010 in Euros?

Eligible: The work and money spent to own and fly glider including TNA from European projects

Non eligible: the work and money spent on projects like GROOM, JERICO, PERSEUS, ...

Please write your answer(s) here:

- Purchase of gliders
- Purchase of sensors
- Glider infrastructure (e.g. Pressure chamber, rubber boat, ...)
- Glider equipment (e.g. tools, R&D, ...)
- Safety equipment
- Batteries
- Iridium
- Argos
- Other consumables
- Other communications
- Spare parts / repairs
- Calibration
- Vessel hire
- Transportation of equipment
- Permanent people
- Contracted people
- People travel
- People training
- People piloting
- Outsourced piloting
- Data center cost
- Shipping insurance
- Glider loss insurance
- Liability insurance
- Other insurance
- Waste disposal
- Other
- indirect cost / overhead (estimate)

17 - Total in Euros

Same questionnaire for 2011, 2012, 2013

45 - Thank you for your contribution.



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