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D1.3

Midterm Review Workshop Report

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1.GENERAL INFORMATION

1.1 ABSTRACT

This document represents a summary of the MARSite Midterm Review Workshop that took place at Hotel and Conference Venue Villa Eur Parco Dei Pini in Rome, Italy hosted by INGV on the 7th and 8th of May 2013.

Intially, A midterm review workshop set be organized at the 18th month of the project with the aim of providing a forum to the Consortium to review progress and discuss any significant problems and deviations and to evaluate intermediate results and to assess quality, impact and effectiveness of project work. The workshop was going to be also be open to the scientific community to obtain a critical evaluation of the progress achievements and future outlook. During the General Assembly on 3rd December 2013 in Istanbul-Turkey, various views were expressed on the Midterm Review Workshop such that the Workshop could combine WP internal meeting in addition to the original intention. There was general consensus that the Workshop should focus on key topics covered within MARSite and that this workshop should be kept as a project internal activity.

The Midterm Review Workshop Report includes the meeting agenda, list of participants, the meeting's minutes, and the revisions of the work program. Comprehensive information on the scientific and technical achievements are presented in the first periodic report. Hence, this report includes a brief summary of this achievements followed by specific debates took place during the event.

44 participants from partners attended the meeting. All presentations made at the MARSite Midterm Review Workshop can be found in the secure area of the project web site: www.marsite.eu

Participants to Midterm Review Workshop

2 MIDTERM REVIEW MEETING

2.1 OPENING

The Midterm Review Workshop was opened by Professor Nurcan Meral Ozel, Coordinator of the MARSite Project, with a welcome speech and a presentation. She emphasized the importance coordination and bringing scientist of different backgrounds in order to share and learn from each other thus making the implementation of MARSite Project very efficient as a multidisciplinary R&D program. She proceeded to thank Paolo Favali and Paolo Mateira from INGV for all their support in organizing the meeting. The opening was followed by introductory WP presentations followed by Q&As.

2.2 INTRODUCTORY WP PRESENTATIONS WITH Q&A

2.2.1 MARSite Management- Nurcan Meral Özel, Project Coordinator

Professor Nurcan Meral Özel shared information regarding the management of the MARSite project and international meetings where the MARSite project was discussed. In her presentation, Prof. Ozel especially focused on the achievements of the project and informed the partners about the delayed deliverables and related counter-measures.

2.2.2 Project Management – Part II: Overview of EC Requirements during the First Reporting Period- *Meral Marina Alguadiş, Project Manager*

Ms. Alguadiş shared information on the financial structure of project management. The issues were the financial and scientific reporting forms of the first period of the project. She informed the participants on the financial reporting required at the end of the 1st Reporting Period and reminde that all Form C's should be submitted to the Coordinator by 10th June. She also emphasized that all expenditures should be according to the EC rules and time sheets should be completed.

2.2.3 WP2-WP11 Presentations

The results of the research and work carried out in each Work Packages was presented on the first day. The presentations can be found on the MARSite website. www.marsite.eu. A brief summary of scientific achievements is given below:

In WP2 "Land-based long-term multi-disciplinary monitoring",the collection of the first comprehensive data set of fluids' composition around the sea of Marmara was achieved during the first reporting period. The first results on the fluids' geochemistry of the area surrounding the Sea of Marmara allowed to gain a better insight on i)the geochemical features of the fluids expelled from tectonic structures around the Sea of Marmara, ii) the origin of the vented fluids, and iii) the occurrence of interactions processes. The data catalogue of 13 spring water and 21 soil radon gas stations in the Marmara region has been generated and the online data are being added to the fluid monitoring database routinely. Online seismological waveform data from KOERI, TUBITAK and KOU networks have been integrated to a common server and a new data server (MARsite Main Server) was established to collect all data from different disciplines. As a result of this, the largest and multi-institutional online seismology waveform data archive for a specific region in Turkey was set up, namely 71 stations in the Marmara region. Moreover, all data in the MARsite Main Server is backed up periodically on the TRUBA (Turkish Science e-Infrastructure by TUBITAK-ULAKBIM, a part of European grid infrastructure) systems in Ankara, Turkey. Online spring water and soil radon gas data was evaluated daily in consideration of the seismic activity and work has been initiated for building a list of target earthquakes for search of possible correlations.

In WP3 "Long-term Continuous Geodetic Monitoring of Crustal Deformation", GPS data process has been continued without any interrupt, and updated version of GPS time series and velocity files were shared via D3.1 "GPS Time Series and Velocity Maps" and the project ftp server. Besides, in order to reduce atmospheric artefacts at the time of acquisition of the different SAR images the Zenith Path Delay layers will be estimated with the help of GPS data processing. The Zenith Path Delays estimated using GAMIT would be input for PSInSAR and SBAS analysis and will be combined for the initial tests to estimate and as far as possible

subtract Atmospheric Phase Screen (APS) with the pre-processed ENVISAT ASAR archive data at selected tracks. Related raw SAR data sets that belong to ENVISAT ASAR sensor were archived under the defined project ftp file structure.

Work on MARsite Satellite Data Proposal took place aiming at allowing the access to extensive SAR data archives to improve the comprehension of the deformation processes already occurred and/or occurring in the Marmara Region. Corresponding proposal was submitted to the Supersites SAC during the first semester (November 2012 – April 2013). The revised version of this proposal based on SAC members' suggestions and condireable input from Project Partners was accepted in April 2014. In particular, procedures aimed at the provisioning of X-band SAR data have been activated by CNR-IREA, which had been monitoring the availability of X-band SAR scenes included in the data provider catalogues to have a clear (and always updated) idea of the SAR data acquisition strategy over the Marmara Region. In addition, CNR-IREA developed a set of procedures to update the SBAS processing chain for processing X-band data from TerraSAR-X sensors. Indeed, the SBAS processing chain was already suitable for ingesting COSMO-SkyMed data, while it needed some modifications to work with TerraSAR-X data. The upgraded version of the SBAS processing chain has been tested on data acquired over areas where TerraSAR-X data were already available.

Persistent Scatterers (PS) velocity maps covering the Marmara region have been made available in the framework of a Service Level Agreement (SLA) between MARsite and Terrafirma projects and PS data from Terrafirma have been analysed during the first period. The main outcome of the analysis of PS data was the clear detection of a post-Izmit earthquake deformation along the sector of North Anatolian Fault Zone (NAFZ) from Izmit up to 200 km toward East (1999 Duzce earthquake).

A zone of anomalous fault slip behavior was detected in the Main Marmara Fault zone segment located close to Istanbul. The nature of this anomalous slip, whether being fully locked or subject to conditional slip has been tested. Results suggest a release of stress that weakens in the postseismic episode. These results are significant, as they may indicate a possible delay of an anticipated earthquake.

In WP4 "Establishment of Borehole Observation System and High Resolution Seismic Studies in the Marmara Sea", one aim is to monitor rupture nucleation and propagation using the borehole and surface array data which necessitates the borehole be right on the fault zone. Since the depth of the bedrock will give the borehole depth and thus the design parameters of the borehole system to manufacture, geophysical measurements were performed at the selected locations to determine the S-wave velocity structure and the depth of the seismological bedrock. Due to the fact that seismic refraction and reflection data didn't allow to go down deeper than 20-30m, deeper results were obtained by Spatial Auto Correlation Method (SPAC) at a site 500m away from the borehole location, which indicated that the engineering bedrock lies at a depth range of 60m-200m. The locations of the surface array stations were prepared for instrumentation (i.e. cabins, seismometer grouting, solar panels and internet connections) and all the surface array stations (currently 8 stations) are in operation beginning from 10th April 2014. As for the borehole instruments; the design of seismometer, dilatometer and the other measuring devices are completed. These

instruments will be transported to Istanbul in Summer 2014 and drilling of the hole will begin simultaneously with the installation of the systems. This process will be completed and be in operation in May.

The Princes Islands segment has been monitored by a variety of local seismic networks, including our PIRES array, which was completed recently with a total of 16 stations on the Princes' Islands offshore Istanbul. In addition to these observations, all available data from these networks to achieve the best possible resolution along this part of the NAFZ have been included. These combined networks include small aperture arrays on two of the Princes' Islands, located there with the aim of lowering the event-detection threshold through beam forming. Data from other, non- array, stations were added to improve the focal coverage. As a result of this effort, the completeness magnitude along the Princes Island segment was lowered by at least one unit, down to about M~1.5. A total of >800 earthquakes were detected and located up to now. This has allowed to study the spatial and temporal evolution of the current Princes Island segment activity in unprecedented detail, providing a new view of its brittle deformation.

Spatial and temporal variations of background seismicity in the western Anatolia and the Marmara Sea have also been studied during this period. An apparent increase on the seismicity rate is observed in the western Anatolia at 2007-2013 period relative to 2001-2007. Selected seismic clusters in regions with extensional character show strong temporal correlations. The clusters as distant as 400km appear to be activated coherently in 2008 within ~30 days. The temporal correlations are also observed in the Marmara Sea, along the Main Marmara Fault. Two moderate size earthquakes (Mw=5.2 and Mw=4.8) occurred on the Main Marmara Fault following two moderate size earthquakes (Mw=6.0 and Mw=5.0) of Simav. Interestingly, the timing of both earthquakes followed two large teleseismic earthquakes (Mw9.0 Tohoku and Mw8.6 Sumatra). Long term (~5 years) and large scale (~50km) variations of seismicity are investigated in the Marmara region in order to understand the response of the Main Marmara Fault to tectonic loading. A high-resolution seismicity catalogue has been compiled for the period of 2007- 2013 which implies three segments of the fault with different seismic behaviour. The eastern segment (Çınarcık Basin) is the most active and shows diffuse seismicity. The seismicity in the Çınarcık Basin (CB) clustered in three sub regions also shows variations on the rate, mechanism and spatial distribution. The segment of Kumburgaz basin is bounded in the east by a seismic activity, which corresponds, to the kink of the Main Marmara Fault (MMF) and in the west to the transition to the Central Basin. A very low level of seismic activity characterizes this segment. The western segment (WM) has experienced 3 earthquakes with magnitudes greater 5 during the observation period. Cumulative seismicity of two segments (WM and CB) with the regional seismicity of the western Anatolia have been compared. It appears that the activity rate of the CB and WM significantly increased during the observation period. Based on seismicity presented, it also appears that the West Marmara region continuously relaxes a significant shear stress through the observed moderate seismicity. Several long-term repeating earthquakes in the West Marmara domain have been observed but none in the KB or CB. The repeater has been observed from January 2008 to March 2012 with very different

recurrence times: from 5 minutes to 9 months. This may be an indication of a continuous loading of the same rupture zone through time and supports the conclusion that the West Marmara region is creeping at least at depth.

In WP5 “Real- and quasi-real-time Earthquake and Tsunami Hazard Monitoring”, the technical structures including electricity, communication and data transfer, renovation of the other critical components of the existing geodetic crustal deformation monitoring network (Marmara Continuous GPS Network-MAGNET) has been updated since the beginning of the project. Possible locations of strong motion stations were determined.

One aim of this WP is to determine finite fault source parameters of an earthquake in order to achieve a comprehensive earthquake rupture analysis of the Marmara Region. The 2011 Mw 7.1 Eastern Turkey, Van Earthquake has been chosen as a case study for its better data set comparing older events in the Marmara Region, in order to reveal performance and compatibility of the two-stage nonlinear kinematic inversion technique of INGV (Piatanesi et al., 2007; Cirella et al., 2012). The methodology for the synthetic kinematic inversion tests has given consistent results by the selected target model (a main slip patch at the left side of the hypocenter) for all types of data sets, especially for the seismic data. Reliable outcomes of separate synthetic kinematic inversion results of strong motion, GPS and DInSAR data gives the opportunity for the application of this technique to the real data indicating that we have a good azimuthal coverage concerning our data sets for the Van case. After the analysis of 2011 Van Earthquake with real data, the performance of the method will be presented more accurately for future works in the Marmara Region.

The other case selected was the 1999 Duzce earthquake (M_w 7.1) occurred on November 12 at 16:57 UTC. Seismic scenarios by considering the slip distribution retrieved by Umutlu et al, (2004) were modeled from the inversion of teleseismic and strong motion data. A discrete wavenumber/finite element technique (Spudich and Xu, 2003) was used to compute full-wave displacement and velocity time histories in the low-intermediate frequency band (up to 3 Hz). The variability of the ground motion by computing PGV, PGD and PSV at 1 sec on a grid of real and virtual sites have been investigated. The slip model retrieved from the inversion of Umutlu et al. (2004) was considered by assuming a rise time of 0.3 sec and a constant rupture velocity of 2.8 km/s. In order to obtain a slip distribution with a corresponding spectra including a frequency content up to 3 Hz, the initial model has been modified by applying a self-similar *k*-square slip model (Herrero and Bernard, 1994). The simulated three-component time series at each sites, both in displacement and velocity, allowed computing peak velocity (PGV), peak displacement (PGD) and response spectra (PSV at 1 sec) distributions.

BRGM has begun simulating ground motions for selected earthquake scenarios (for ground motion prediction) as well as recent moderate earthquakes (to validate the model

parameters). The finite-difference code was tuned in order to include all the Marmara region of interest. The simulations show the introduction of a 3D model improves the ground-motion waveforms around the Marmara Sea, while there remains some validation or calibration to do.

Ground motion scenarios for the city of Istanbul for the high frequencies were estimated. A stochastic approach to compute acceleration time series for direct S-wave field at bedrock sites (EXSIM; Boore 2009) was used. The methodology is capable of capturing the complexity of near-source ground motion even when input data regarding earthquake source, propagation medium, and site characteristics are of a very schematic nature and it allows using different rupture models on the selected fault. The earthquake scenarios considered consist of the rupture of the segments of the North Anatolian Fault System close to the city of Istanbul. Three fault rupture scenarios for the selected fault segment (the Central Marmara Fault) based on the location of the hypocenter and the tree different slip distributions on the fault were defined. The effect of location of the slip asperities were analyzed within the Central Marmara Basin on the subsequent ground motion. The fault geometry and asperity parameters for the earthquake scenario were determined from empirical scaling (Wells and Coppersmith, 1994). The resulting ground motions in and around the city of Istanbul were calculated and the sensitivity of the predictions to the choice of model parameters have been evaluated.

The deliverables D7.2 GIS Database of the fault parameters “and “D7.4 Revisited historical earthquake catalogue have been provided internally have contributed to the task of creating a scenario database for earthquake triggered tsunamis and testing of the routine with well-studied events. In addition, KOERI compiled also a Moment Tensor Catalogue from existing available sources such as EMMA, SHARE, ISC and KOERI Catalogues and work towards creation of a Historical Earthquake Database is in progress. Once created, this database will be cross-examined with D7.4 and if possible, will be used in the improvement of it. Due to the availability of detailed fault source information in the Marmara Sea, fault segments with associated grids of 0.1° x 0.1° size will be assigned with source parameters (strike, dip, rake and displacement) where combination of these segments will lead to higher magnitude earthquake scenarios to be used in tsunami modelling. Topography and bathymetry data sets to be used in the tsunami have also been created during the reporting period.

One other aim of WP is the reinvestigation of the probabilistic seismic hazard in the Marmara region in the light of new data and methods. Fault source and background seismicity modelling approach is adopted for the representation of source zonation. The applicability of Poisson and time-dependent models for the earthquake recurrence of the fault sources has been investigated. The comparisons so far have yielded favourable results for the tested Ground-Motion Prediction Equations (GMPEs). However, the final decisions on the selection of the GMPEs as well as the weights to be assigned will be determined in the

next period, based on comparisons of other ground motion parameters, such spectral accelerations (SAs) at various periods, as well, as well as on the range of estimated hazard values.

Another aim of WP5 is the computation of the occurrence probability of a characteristic earthquake for the 5-10-30- and 50 year periods (starting from January 1, 2013) on 26 individual seismogenic sources in the Marmara region, considering the uncertainties in the slip rate, characteristic magnitude and aperiodicity of the statistical distribution associated to each examined fault source, by a Monte Carlo technique. Consequently another parameter comes into play is the average recurrence time. The Monte Carlo samples for all these parameters have been drawn from a uniform distribution within their uncertainty limits. The overall uncertainty of the recurrence rates is determined by varying the fault/source parameters simultaneously. The analysis indicated that when considering the 50th percentile for the next 50 years, according to Poisson and BPT models, that the largest value of the occurrence probability for the Poisson probability are observed on the faults Manyas, Cinarcik, West Marmara and Duzc , while the largest value of the occurrence probability from BPT renewal model may be observed for Cinarcik, Western Marmara and Bursa faults. The impact of fault parameter uncertainties (maximum magnitude, and slip rates) on the ground motion hazard for Poisson and BPT forecasting models have also been considered. The uncertainty in the hazard estimates may be reduced significantly by properly modeling the seismic sources and selecting suitable ground motion models and will be the future research in a separate study. To generate uncertainty maps, the difference between the 50th and 10th percentiles and the 90th and 50th percentiles are selected to indicate the value to be added or subtracted from the hazard map value to obtain the upper and lower limits. As a summary, it could be indicated that the uncertainties are larger around the Izmit, Duzce, Pazarkoy, south Saros, and Manyas faults area for the time-dependent hazard (around +0.40 g) respect to Poisson case (+0.10 g).

In WP6 “Earthquake-Induced Landslide Hazard in Marmara”, bibliographic survey has been accomplished about the landsliding issue related to the on shore pilot zone to be studied, i.e; the Avcilar peninsula. Two field visits of several landslides have been undertaken with local partners along with technical meetings to discuss about selection of a pilot landslide for in depth investigations and instrumentation and organize pre-exisiting data transfer between partners. The pre-existing GIS including DEM and landslide mapping (raster files) have been transferred from Tubitak. Based on a literature review, a methodology to develop a dynamic system based on GIS technology to create advanced mapping of landsliding hazard combining theoretical slope stability models relying on variable on-site transient data (mainly rainfall, watertable, and seismic shaking) has been designed. This is to include site effects mapping as a prominent parameter for quantifying earthquake induced landslide geohazard assessment. The structure of the dynamic GIS was developed as an automated process ready to be parameterized. It is designed to integrate progressively expected further

dataset to be available, as geological, geotechnical and geophysical parameters. These should come out from parallel research works as well as from recently launched geotechnical survey of the area through the Istanbul Metropolitan Municipality project undertaken in the region. In the automated process geomorphology, geology, geotechnical and site effects are pre-determined constant parameters part of the model. PGA and earthquake characteristics, recent past rainfall and watertable are modelled as dynamic parameters enabling the on request calculation of susceptibility and Newmark displacement map on request. An in situ multi-parameter observational system, including displacement, rainfall, seismic shaking and piezometric measurements has been designed with partners and prepared by INERIS to be set up on the field as soon as all necessary authorizations are obtained by Tubitak and local partners. The monitoring system will be set up also as an early warning system prototype to be progressively tested and shifted towards near to real time conditions.

During MARMARA2013 oceanographic cruise, carried out onboard of R/V Urania of the Italian CNR between September 19 and October 14 2013, new high-resolution seismic reflection and morphobathymetric data over the large slump complex at the entrance of the Izmit Gulf in the Eastern Sea of Marmara was collected. Such new data enabled to complete the mapping of this large, potentially dangerous feature, including its in-plan dimensions and the depth of the potential sliding surface. Morphological studies of minor structures, such as canyons and gullies cutting this feature, have been carried out to detect piercing points possibly diagnostic of its kinematics and time of emplacement. Finally, high resolution morphobathymetric data allowed to follow the trace of a fresh surface rupture affecting the frontal lobe of the slumping body (Eastern Cinarcik Slumping Body, ECSB), possibly due to the effect of the 1999 Izmit earthquake. All of these indicators will be used to reconstruct the evolution of the ECSB in the past and to figure out future scenarios. In fact, because this large slumping body is located on the western termination of the 1999 Izmit earthquake surface rupture, it is possible that it will be activated by the next Istanbul earthquake, that is expected in the next decades. For this reason, work is in progress to model the tsunamigenic effects of a possible future slumping slumping on the coastal areas surrounding the Eastern Sea of Marmara, that will be heavily affected by such event in case of a large (M > 7) earthquake in the Istanbul Area.

One aim of WP6 is to find a relation between seismic activities and landslides. The corresponding study concentrated on the primary data from post-earthquake investigations to determine general characteristics of landslide occurrence. This type of study provides the basis for increasing numbers of seismic landslide-hazard and slope-stability analyses on a variety of scales. The study additionally did review on three selected topics; the occurrence of landslides at great distances from earthquake sources, field verification of earthquake intensity thresholds and delayed activation of landslide movement by earthquake shaking. Post-earthquake field investigations of landslide occurrence provide a basis for

understanding, evaluating and mapping the hazard and risk associated with earthquake-induced landslides. Some of earthquakes of Mw>3 with surface displacement data from PS-InSAR processing have been correlated. Figure 6.2.6 shows earthquake distributions around Marmara region and western Anatolia. However, a strong relation between the seismic activity and the displacements is difficult to see. Only for some of events, it is possible to observe a clear increase or decrease of the surface displacements.

The detailed field survey carried on by IFSTTAR-" La Sapienza" on April 2013 resulted in the selection of 9 landslide processes of particular interest as they consist on active, rototranslational landslide which are characterized by counter slope terraces, main and secondary scarps, evidences of retrogressive kinematic. Based on the DEM provided by KOERI-TUBITAK and considering the on-line available satellite images (Google-Earth) each landslide a geomorphological map of each landslide was obtained and the main morphological parameters were derived (i.e. length, width, thickness and failure mechanism). Moreover, taking into account the evidences collected during the field survey, an engineering- geological characterization was also performed, also considering the local geological setting. In this regard the main lithotechnical units were recognized in each landslide area and detailed engineering-geological maps were obtained. Based on these maps geological cross sections were reconstructed along longitudinal tracks corresponding to each inventoried landslide. As it results from this geological reconstruction the 9 inventoried landslides are characterized by an active state and by translational to rototranslational mechanisms and they generally show a multiple, multi-stage style, i.e. as proved by the existence of several order of landslide terraces. The failure surface mainly involve silty-clay deposits while the landslide masses also involve different lithotechnical units including calcarenites, marls, sands, and conglomerates.

In WP7 "Re-evaluation of the seismo-tectonics of the Marmara Region", geological synthesis of the Marmara Region from Eocene to present is completed and accepted for publication. Nature and distribution of activity along the North Anatolian Shear Zone (NASZ) in the Marmara Region has been finalized and Neogene Sediments have been mapped and correlated within the Sea of Marmara. Fault systems, which were formed during the evolution of the NASZ and the Thrace Basin have been compiled. Mapping of active faults for all the Marmara Region have taken place in addition to collection of new Marine Geology data and processing and revision of previously collected data. Paleoseismological studies along the middle strand of the North Anatolian Fault has been conducted and subaqueous paleoseismology of the Sea of Marmara by the study of seismo-turbidites from the collected sediment cores has been determined. Compilation of historical earthquake data has also been finalized. Study of sediment cores to unravel the historical and proto-historical record of large magnitude earthquakes. Development of a segmentation model for the Marmara area by integrating different data has also taken place during this reporting period.

In WP8 "Monitoring seismicity and fluid activity near the fault using existing cabled and autonomous multiparamater seafloor observatories", KOERI obtained 6 months-long time

series from 3 sea-bottom seismometers. At this stage, no time-series has been collected yet within MARSITE by INGV and Ifremer from autonomous seafloor observatories. One major achievement within this WP was the completion of the MARM13 Cuise of R/V Urania by CNR-ISMAR, from September 19th to October 10th 2013, which allowed the deployment of one multi-parameter observatory SN-4 at the entrance of the Gulf of Izmit ; 4 OBSs from INGV and 2 piezometers of Ifremer on the Western Sea of Marmara, near the Western High where a mud volcano was discovered in 2007, within less than 1 km from the North Anatolian Fault trace. Analysis of broad-band seismological data (GURALP CMG-40), collected by a network of 3 permanent, cabled, sea-bottom observatories installed on the Marmara seafloor took place and work to improve earthquake location by using a 3D velocity model and by integrating land (from KOERI, TUBITAK and other Projects) and sea stations (from Ifremer) was conducted. Elaboration of a 3D velocity model of the Marmara area to improve high resolution earthquake locations took also place during this period. Integration of the permanent, cabled OBS data provided by KOERI to the Ifremer dataset collected with a non-permanent OBS network deployed in the Western Sea of Marmara, from March to August 2011, has been realized. In addition, high-resolution earthquake localization in the near-vicinity of the Main Marmara fault, using sea-bottom stations only and an ad hoc velocity model, specifically designed for the deep, sediment-filled, northern Marmara trough, has taken place.

One main objectives of this WP has been defined as to correlate time series of fluid emissions and fluid pressure in the sediment with other recorder parameters (e.g. water column parameter and seismicity) and analyse bottom pressure reccords in search of resonant frequencies influencing the characteristics of tsunamis in the Sea of Marmara. Work has started on the limited data set currently available. Several characteristic pressure oscillation frequencies were identified in the period range 24-150 minutes in data from a bottom pressure recorder deployed in Tekirdag Basin in 2007. The power spectrum differs from prevously reported spectra from near shore pressure gauges. A prominent peak is found in the power spectrum at 78 minutes. Acquisition of data from other locations is needed before the results of the frequency analysis can be interpreted in term of water column (seiche) oscillations. The possible relationship between shallow aftershocks of a >5 Mw earthquake that occured below the Western High and fluid emission through a mud volcano is under critical evaluation. Relocalization of microseismicity from OBS data is performed using several different methods and velocity models to assess the robustness of this result. Work on the preparation of the next generatIon of seafloor observatorIes for geo-hazard monitoring has been conducted.

In WP9 “Early Warning and Development of the Real-time shake and loss information”, additional instruments (SOSEWIN) have been installed in a building next to the vertical array in Ataköy (Istanbul) in order to allow future monitoring of wave propagation from the underground to the building and vice versa. This will allow the characterization of soil-

structure interaction that generally is only estimated via numerical simulations carried out with very simplified models. Furthermore, first standard analysis to estimate the dynamical characteristics of the building (typical for this part of Istanbul) were carried out and the developement of new ad-hoc procedures for real time health monitoring is in progress. Some preliminary results have been obtained in developing algorithms to assess damage from spaceborne Earth Observation radar data. KOERI is working on the improvement of existing Rapid Damage Assessment Tool (ELER) for GMPEs in Marmara Sea events. The automatic shakemapping with the information from stations (SM, BB) has been achieved. The number of SM stations have been increased with the integration of Istanbul Natural Gas Distribution Company (IGDAS) SM network.

In WP10 “Integration of data management practices and coordination with ongoing research infrastructures”, D10.1 “First report on the integration and links to other initiatives” was submitted that reports all the European and international initiatives and projects that could have links with MARsite. In terms of development of standards for metadata, data models and services following International norms, D10.3 “Report on international standards on architecture principles, metadata, data models and services and improving links with other projects” was produced, where each chapter of this deliverable addressed a different aspect of such a distributed system, namely: metadata, data models, the web services themselves and, finally, the portrayal of the data. Existing standards and systems were summarised, their relevance for MARsite detailed, and ideas for future developments suggested. In order to demonstrate how such a distributed system would work and to clearly show the benefits of adopting such an approach for MARsite, and Supersite projects in general, a portal was created by BRGM to serve various data collated or generated within the project or already available online from previous projects. As far as ESA EO data are concerned, Virtual Archives for selected data have been created, which are queriable through a webinterface and expose an OpenSearch interface that can be queried directly by the MARSite webportal. As far as exploitation platforms are concerned, dedicated Virtual Machines have been configured for the MARSite project and different algorithms have been integrated. This will offer the users with ready-to-be-used services. At the present the algorithms are being tested and will be released in the next period of activity.

In WP11 “Dissemination”, MARsite website has been set up by WP1 which is fully optimized for search engines (Google, Bing…) and updated as often as necessary with news, events and publications by WP11. Marsite uses the social media accounts of the partners to disseminate key messages. The Marsite Website is the repository to which users are drained in order to raise the trafic on the website and give the opportunity to the users to discover every aspects of the Marsite Project. Marsite materials were spread within Facebook (12 438 fans), Twitter (4 381 followers), Google+ (500 contacts), Linkedin (Company page) and Pinterest (within « EU projects » board). Five short videos describing the project are available in the MARsite project website. They are based from interviews of the project coordinator (Prof.

Nurcan Meral Özel, KOERI) and 3 WP Leaders (John Douglas, BRGM; Louis Geli, IFREMER; Paolo Favali, INGV). The ID Card and the ID Poster are displayed or distributed during conferences and workshop. The MARSite newsletter aims at spreading MARsite latest news. It is issued every 3 months and distributed through various channels (e.g. mailing lists, partners' social networks, and websites). The new newsletter formula is now thematic in order to facilitate the dissemination of the MARsite project through key messages (especially on social media). All newsletters are available on the website.

2.3 WORK PACKAGE PARALLEL SESSIONS

The WP4, WP5, WP6, WP8, WP9, WP10 parallel sessions were conducted in the second day of the Midterm Review Workshop. The purpose of the WP sessions was to bring each WP contributors together to discuss all possible details of the work foreseen within the WP.

2.3.1 WP4: Establishment of Borehole Observation System and High Resolution Seismic Studies in the Marmara Sea

- Surface array stations currently running in off-line mode will be real-time in the latest third week of May,
- The broad band borehole system is completed and data for this device, both the broad band and the strong motion was presented and discussed.
- The details of the tilt meter sensor that will be installed below the broad band seismometer with in the borehole was discussed. The three jaw stable tilt meter platform is ready to be installed as soon as the borehole is drilled.
- Drilling of the hole for borehole observatory and installation of the equipment (broadband seismometer, accelerometer, tilt meter, temperature meter) will be completed by the end of June 2014. If the dilatometer will be ready by the end of June it will be installed simultaneously with the borehole casing, if not, the dilatometer will be installed in a separate hole when it is ready.
- The design and the specifications details of the multidisciplinary borehole observatory was extensively discussed and likely methods of installation scenarios was reviewed.
- It was agreed that at this stage of the project the main requirements as presented in the plot below (Fig1) is achieved. The evaluation of the manufactured equipment in a test borehole in UK clearly shows the expected specifications have been comfortably met for the broad band and strong motion sensors. The given plot was presented at the Rome meeting.

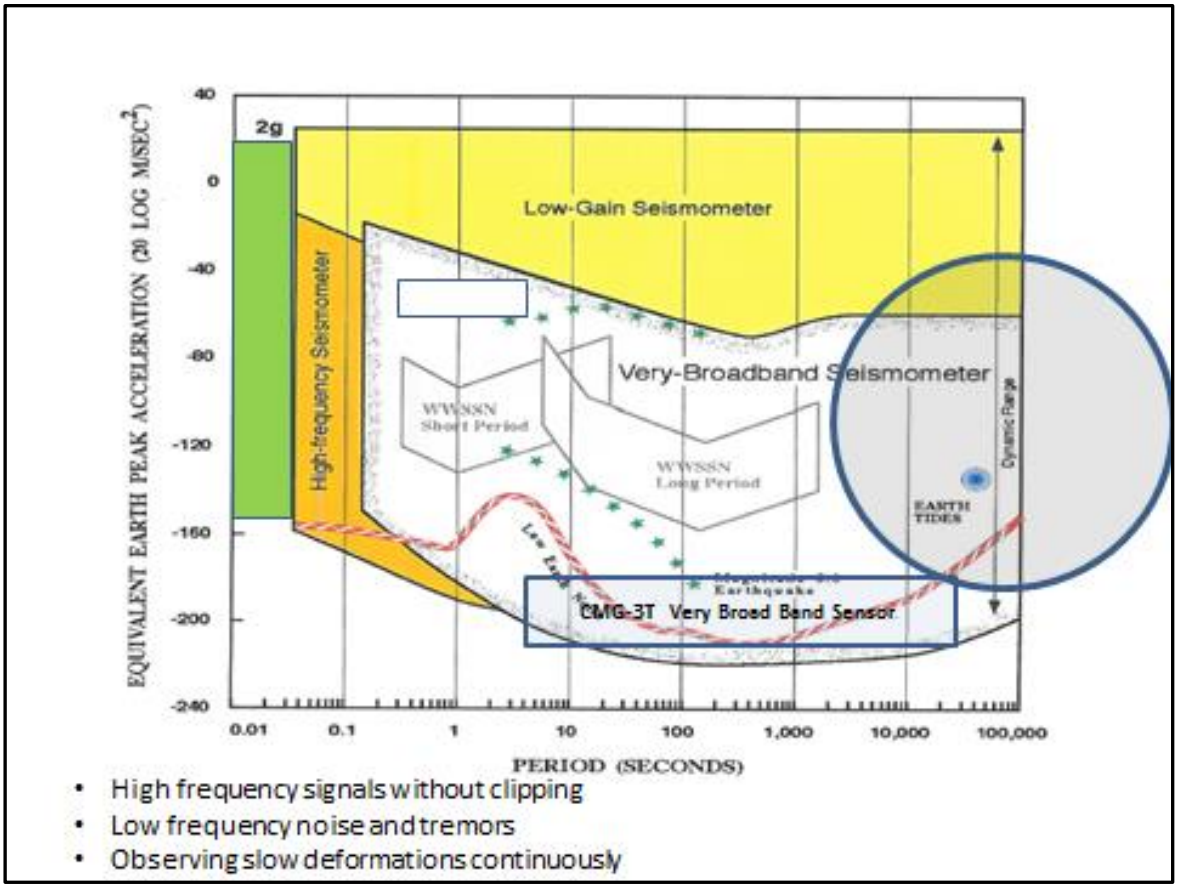

Figure 1 : Multidisciplinary borehole observatory seismic band

2.3.2 WP5: Real- and quasi-real-time Earthquake &Tsunami Hazard Monitoring

Task 1: 6 GPS stations to be upgraded in the next 6 months and 2 new GPS locations to be installed within the next month. In addition 16 strong motions stations will be deployed.

Task 2: The intention in this Task is to study the variability of the ground motion. The first goal is to retrieve the rupture history by applying methodologies developed by INGV on the 2011 Van Eastern earthquake example. The kinematic inversion technique implemented involves joint and separate inversion of strong motion, GPS and DInSAR data, where the finite fault is divided into sub-faults and kinematic parameters are allowed to vary within a sub-fault. Models having a local rupture velocity larger than P-wave velocity are discarded and several analytical slip velocity source time functions (STFs) are implemented. Different crustal models can be adopted to compute Green's functions at different receivers. Inverted parameters are Peak Slip Velocity, Rise Time, Rupture Time, Rake. Synthetic tests have been performed for all technologies at which all the inverted models obtain were found to be very similar to the target one. The position of the slip patch is correctly imaged and the kinematic parameters values (in terms of peak slip velocity, rake, rise time and rupture time) are well estimated. These results ensure that a quite good azimuthal coverage exist and they indicate the reliability of the adopted technique and the resolution of the retrieved rupture model for each dataset inverted is adequate. Work on real data has been started and work is in

progress to solve the trigger time problems associated to the data recorded by the Iranian Network. KOERI will try to establish contact with their counterparts in Iran. Individual data set inversions will take place to determine associated weights for the joint inversion.

Concerning D5.3, INGV proposed to consider an observational network of GPS and SM-BB data in Marmara and construct synthetics for "future" events and produce a dataset to be used blindly. The question is whether to rely only to kinematic code or also introduce dynamic codes. Dr. Wang from GFZ is also working on the kinematic synthetics. Dr. Aochi pointed out that it is feasible to use the dynamic code. The purpose would be to test te performance of the codes for a future event. A scenario generator is needed by one institution and another institution could work on the inversion to ensure objectivity of the study to assure the validation. Several level of complications in the model could be considered.

Concerning D5.4, clarification on the most relevant earthquake source parameters is needed, which were defined as (e.g. moment magnitude, fault size, rupture duration, slip centroid) rather than achieving a high spatio-temporal resolution in the DoW.)

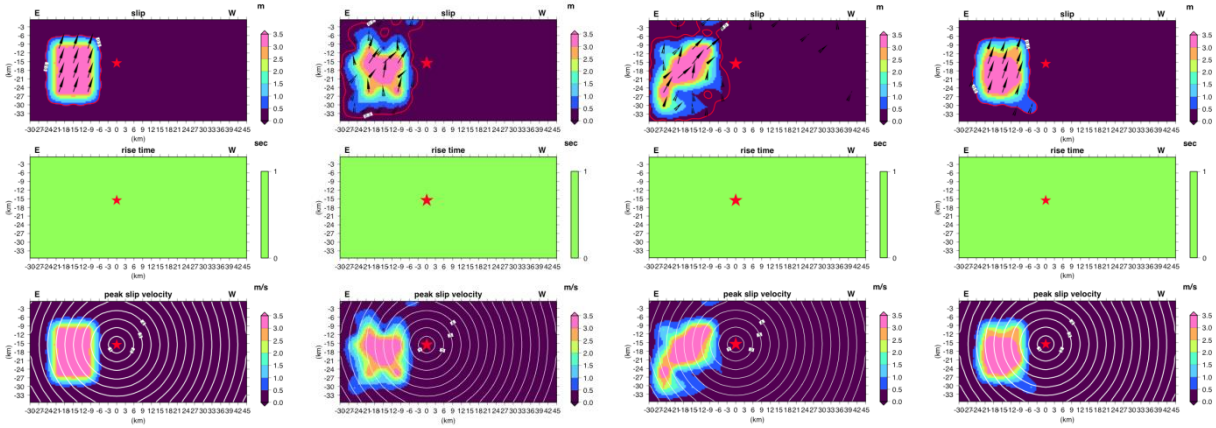

Figure 2: From left to right, target rupture model, GPS, InSAR and strong-motion inversion results from the synthetic tests.

Task 3: 3D model from Bayrakci, 2013 will be used in the simulation. KOERI will provide 150m resolution bathymetry data to BRGM. Test case is 25.7.2011 ML=5.2 eq in the Marmara Sea. The question is whether the 3D Model would be more useful than the 1 D model. Intial results indicate that 3D approach is better than 1D even though there is no superior difference. Alternative body-wave inversion methodology wil be used in EQ localization and mechanism inversion. A 3D velocity model in this inversion will be used to seek for improvements. The reciprocity principle will be used for the pre-computations of the Green Functions. Computations will be performed for 5 elementary source mechanisms to be used to derive more complex mechanism related results. Preliminary tests has been initiated.

Task 4: The work on the compilation of the historical seismicity and moment tensor catalogues have been finalized. The outputs of Tasks 7.1 and 7.2 are expected to be provided

internally at M19 and will contribute to this task. Grid locations to be used in the creation of the tsunami scenario database are identified. Topography and bathmetry data sets to be used in the tsunami modeling are created. The first deliverable of this task, D5.6 Characteristics of tsunami source region in the Marmara region, will be submitted in due time at M24 (October 2014). The Results from INGV in WP5 and ITU in WP7 will be utilized to determine fault/segment parameters and associated tsunami modeling.

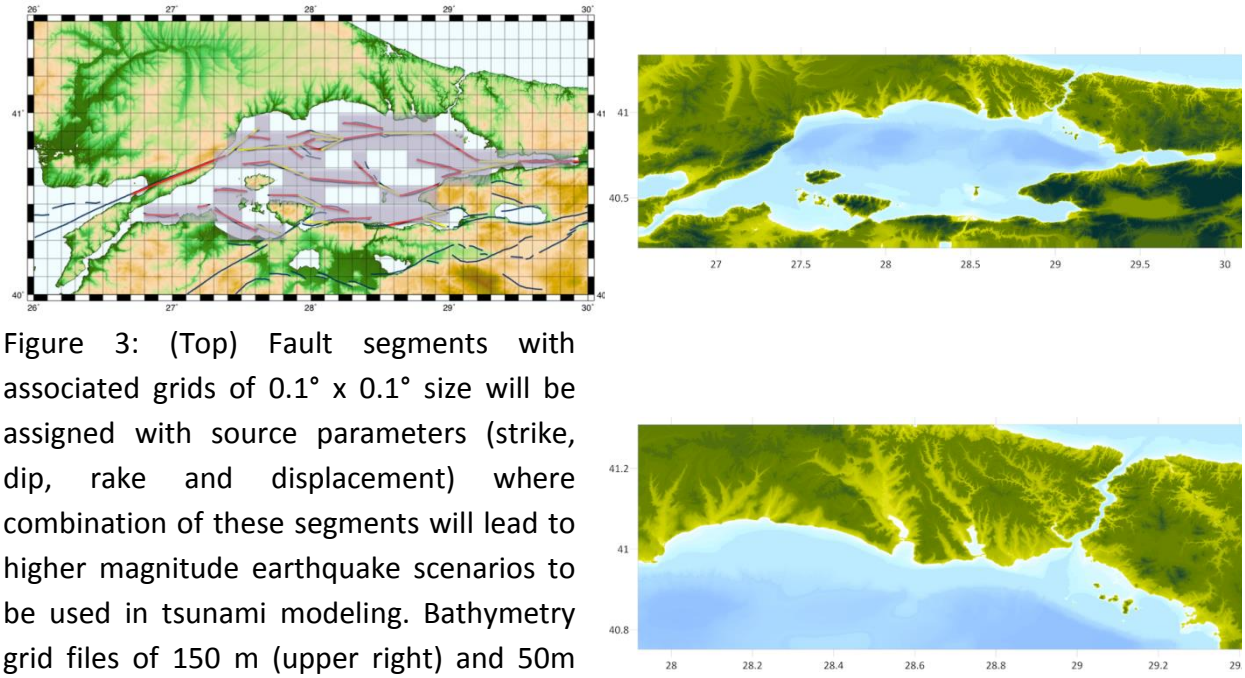

Figure 3: (Top) Fault segments with associated grids of 0.1° x 0.1° size will be assigned with source parameters (strike, dip, rake and displacement) where combination of these segments will lead to higher magnitude earthquake scenarios to be used in tsunami modeling. Bathymetry grid files of 150 m (upper right) and 50m (lower right) resolution to be used in tsunami modeling.

Task 5: This Task will also benefit from WP7 results, including the catalog. The fault database is crucial for this Task. The slip rates and fault geomtery combinations could be utilized also in this Task. INGV pointed out that smaller magnitude catalogs would be useful to investigate the clustering and may assist to deal with the uncertaintes.

Task 6: Work is in progress in connection with EU FP7 projects of REAKT in the creation for developing short-term earthquake forecast maps.

2.3.3 WP8: Monitoring seismicity and fluid activity near the fault using existing cabled and autonomous multiparameter seafloor instrumentation

During the parallel session, permissions for the Marsite Cruise, coordination with the Japanese group (JIC/JST-SATREPS) and recovery of SN4 has been discussed.

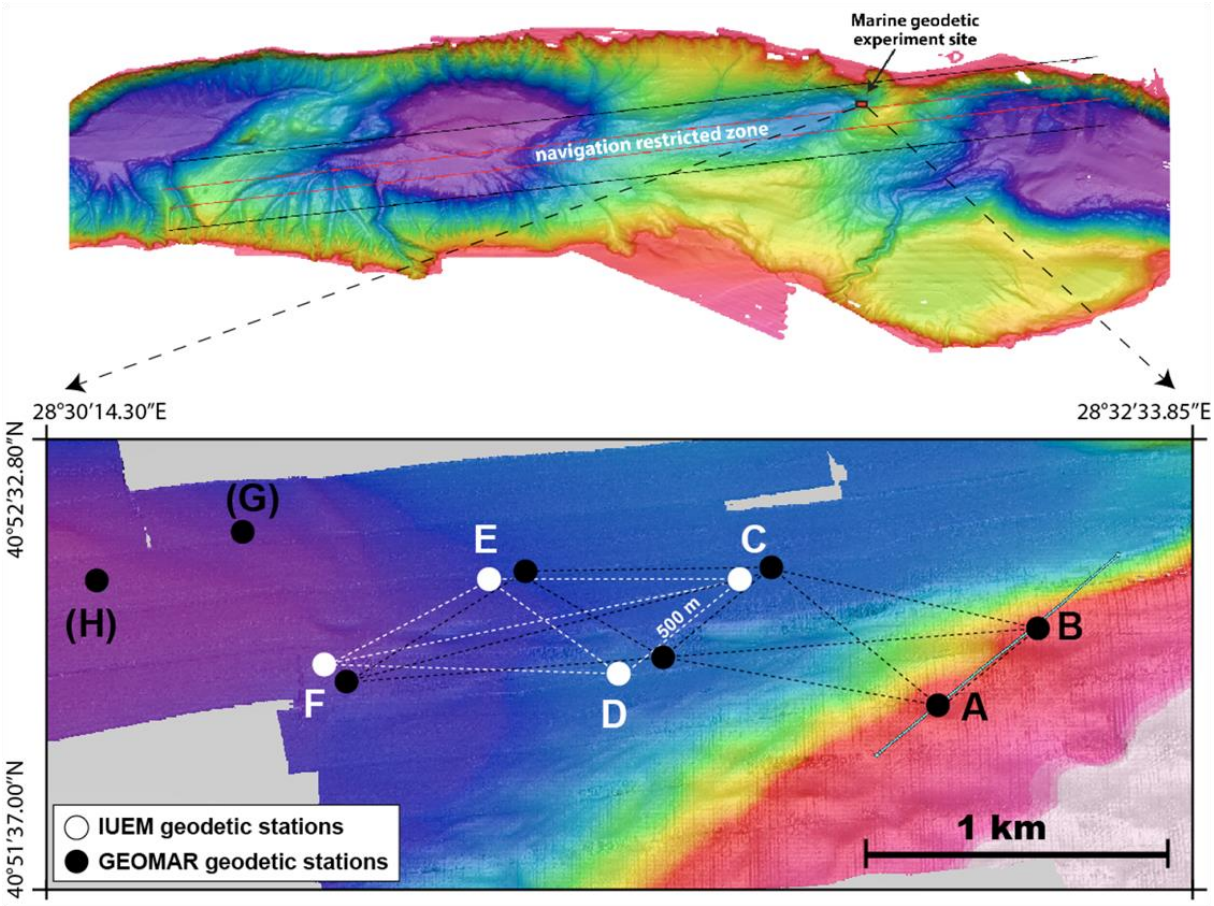

Figure 4: Locations of the geodetic stations and area of restricted nazigation zone in Marmara Sea

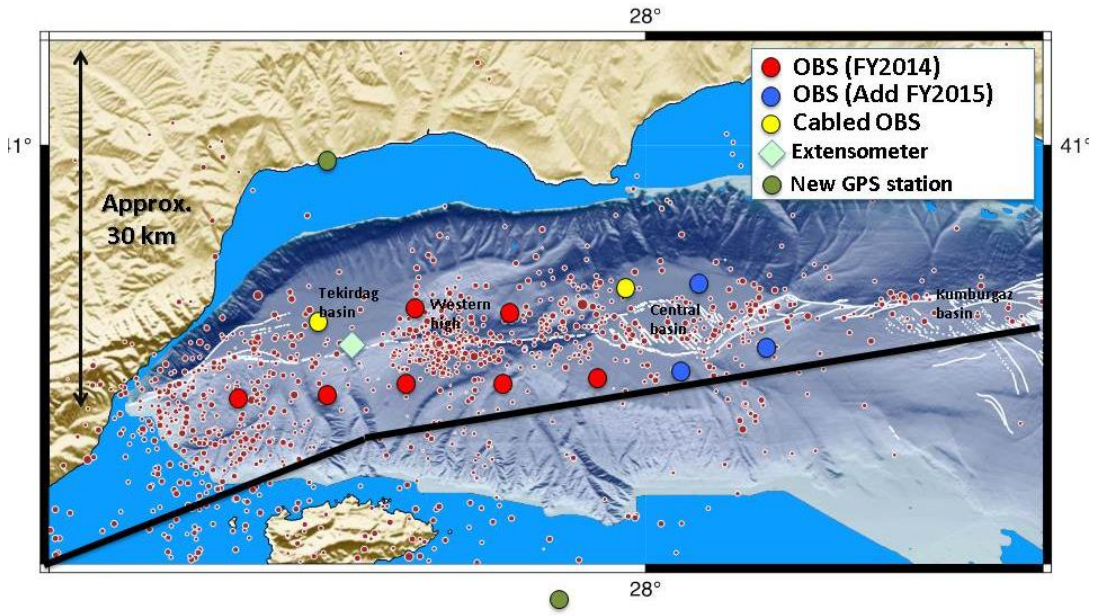

Figure 5: Locations of OBS' deployed in March 2014 and recovered in June 2014 within the JICA/JST-SATREPS (Japan) Project (red). Blue circles indicates locations of OBS' to be deployed during September 2014 – June 2015.

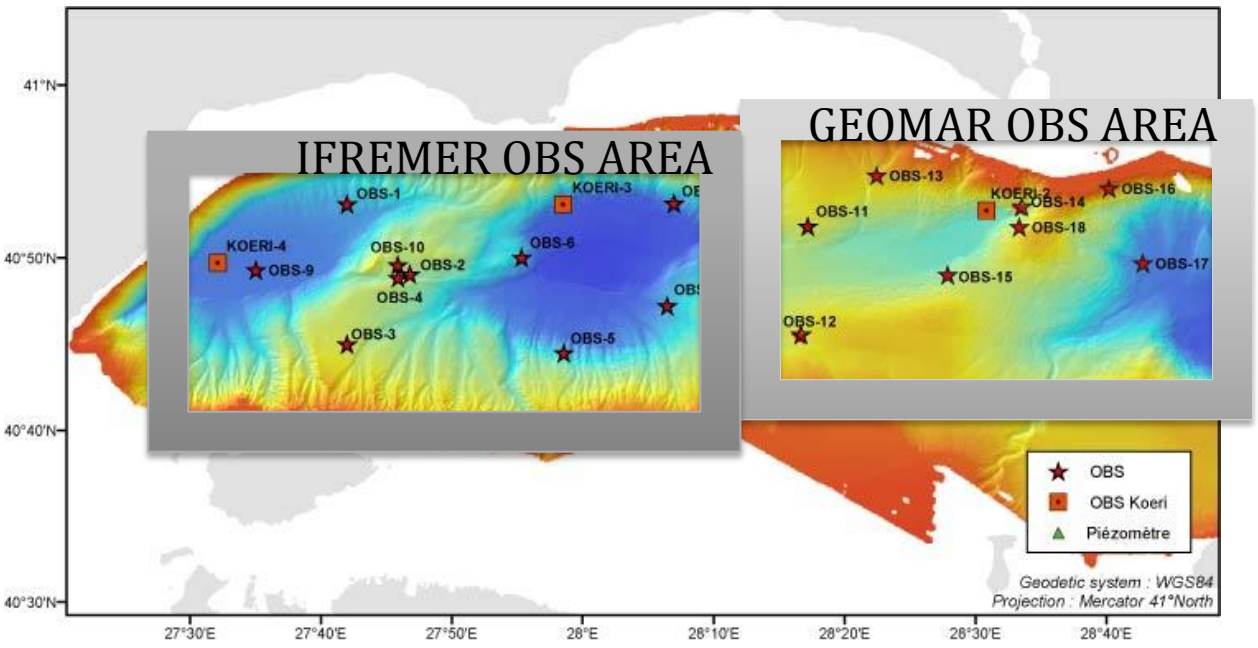

Figure 6: Details of IFREMER (left) and GEOMAR (right) OBS areas.

2.3.4 WP9: Early Warning and Development of the Real-time shake and loss information

Task1 : Improvement of risk assessment in Istanbul with incorporation of new data, techniques and methodologies (M. Erdik- KOERI, EUCENTRE, GFZ)

- Some interpolation methods with recent event records in Marmara Sea have been studied by KOERI and will be reported.
- Spatial variability of the ground motions will be studied by KOERI and reported.
- KOERI will share Nov27, 2013 M4.7 Marmara Sea event ground motion distribution for Cekmece area with INERIS for their work in Task2.
- INERIS will share the information of stations they are working in WP6 with KOERI.

Task2 : Development of a pilot landslide EW system (A. Ansal - KOERI, INERIS)

INERIS prepared all the equipments for 3 boreholes in the pilot landslide area in Cekmece district in Istanbul. The boreholes is planned to be drilled in June in the area collaboration of INERIS with TUBITAK. 1 borehole will include 2 piezometers and 2 seismic stations and will be supplemented by 2 other boreholes for data acquisition. INERIS is waiting for a final authorization from IBB for borehole installation.

Task3 : Improvement of the Istanbul Earthquake Rapid Response System with incorporation of new online data and incorporation of new methodologies (C. Zulfikar- KOERI, AMRA)

KOERI is working on the improvement of existing Rapid Damage Assessment Tool (ELER) for GMPEs in Marmara Sea events. The automatic shakemapping with the information from stations (SM, BB) has been achieved. The number of SM stations have been increased with the integration of IGDAS-SM network.

Task4 : Seismic Vulnerability Integration and GEO Showcase (F. Dell'Acqua , EUCENTRE)

Some methodologies have been already developed by EUCENTRE, but some others are still under development. EUCENTRE is waiting for the high resolution data for Istanbul area. Once they have this data they will be able to apply the methodologies they have already developed. In order to validate the results it will be also good to have the building inventory information of the same site.

2.3.5 WP10: Integration of data management practices and coordination with ongoing research infrastructures

It was agreed to start work on D10.2 (the update of D10.1) as soon as possible to aim for completion by September. INGV will start with the list of projects and initiatives identified in D10.1 and highlight those that we should seek collaboration with. This prioritised list will be sent by the end of May to BRGM and KOERI. An email will be drafted by BRGM (with help by INGV and KOERI) to the projects to seek links with MARsite, e.g. by exchanging data. Collaboration with other Supersite projects, EPOS and GEO will be maintained and strengthened.

2.3.6 Data Sharing Discussions

During the Midterm review Workshop, a lot data was presented. The purpose of this discussion session was to stimulate options of how all these data can be used together. The level of the epistomological uncertainties differ among the data available. One of the main issue is how to make the data available to the whole consortium in an effective way. From the WP10 point of view, visualization of certain data sources is already in place. Two platforms are available; these are marsite.eu and ftp://193.140.203.221, where different types of data files could be accessed from these.

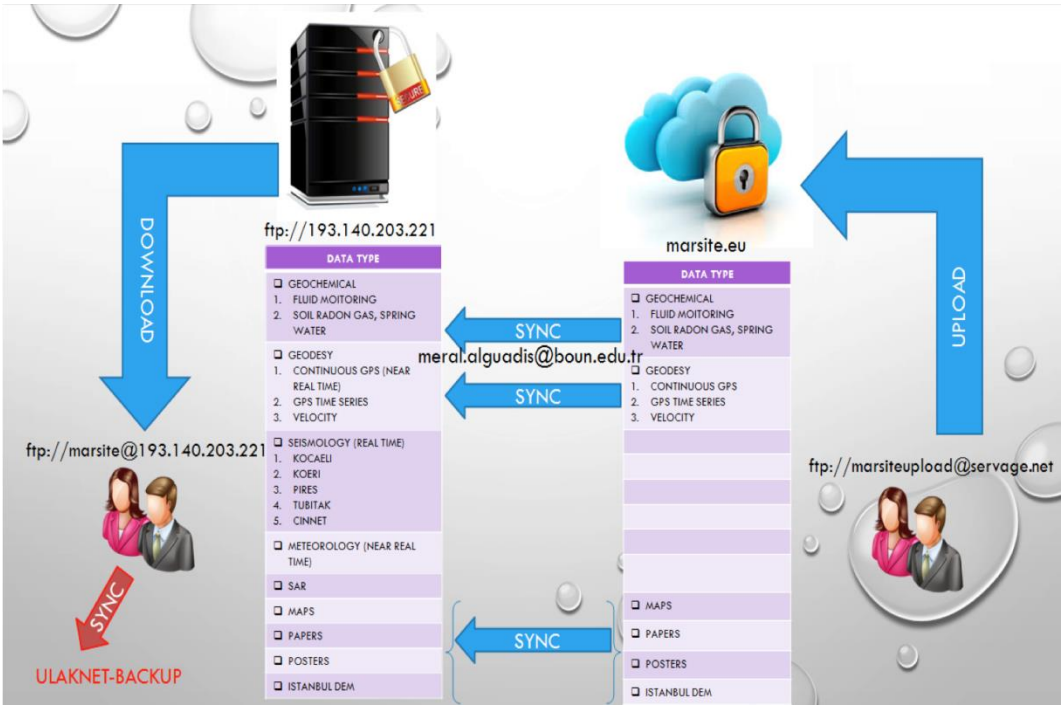

Figure 7: Schematic representation of internal data availability within MARSite Consortium

An additional interface is available at marsite.eu/mseed to download seismic data in mseed format. It was emphasized that EQ catalog and the fault database from WP7 should also be on marsite data servers. Perhaps, at the end of the project it could be feasible to establish a web site with an interactive map of the study area with information associated on various interpretations – brief summary and links to relevant publications.

Data fusion should also lead to harmonize or cross-evaluation the interpretations based on the data analysis.

2.3.7 Other issues

During the discussion, several scientific topics of discussion for the General Assembly meeting are decided. These are:

- Is CMB creeping or not
- Is the shallow seismicity is gas induced?
- Which clusters are driven by the fluids?
- What is the best approach to evaluate slip rates?
- What is/are the most crucial areas in the Marmara Sea to be studied?

These 5 questions will form the basis of a scientific session to take place at the next General Assembly.

2.4 CLOSING

2.4.1 Closing Remarks

In her closing remarks Professor Özel stated that in the Midterm Review Workshop all partners were able to better understand the intricate nature of the project and share valuable knowledge. She urged the WP leaders to continue meetings and discussions within their task groups and among each other in order to facilitate the collaboration of partners.

Furthermore she thanked all the partners for their participation and INGV for hosting in the Midterm Review Workshop.

Annex I: Agenda

Agenda Midterm Review Meeting

Day 1 – May 7th, 2014		
09:00	Session 1: Opening Session	Nurcan M. Ozel Project Coordinator
	Session 2: Progress Report WP Presentations with Q&A	
09:40	WP2: Land-based long-term multi-disciplinary monitoring	Paolo Favali INGV – WP2 Leader
10:20	WP3: Long-term Continuous Geodetic Monitoring of Crustal Deformation	Semih Ergintav TUBITAK - WP3 Leader
10:40-11:10	Coffee Break	
11:10	WP4: Establishment of Borehole Observation System and High Resolution Seismic Studies in the Marmara Sea	Asım Oguz Ozel IU - WP4 Leader
11:50	WP5: Real- and quasi-real-time Earthquake &Tsunami Hazard Monitoring	Nurcan M. Ozel KOERI - WP5 Leader
12:30	WP6: Earthquake-Induced Landslide Hazard in Marmara	Pascal Bigarre INERIS – WP6 Leader
13:00-14:00	Lunch	
14:00	WP7: Re-evaluation of the seismo-tectonics of the Marmara Region	Ziyadin Çakırr ITU – WP7
14:40	WP8: Monitoring seismicity and fluid activity near the fault using existing cabled and autonomous multiparameter seafloor instrumentation	Louis Geli IFREMER - WP8 Leader
15:20	WP9: Early Warning and Development of the Real-time shake and loss information	Can Zülfikar KOERI – WP9
16:00-16:30	Coffee Break	
16:30	WP10: Integration of data management practices and coordination with ongoing research infrastructures	John Douglas BRGM – WP10 Leader
17:10	WP11: Dissemination	Caroline Etivant-Dernoncour EMSC - WP11 Leader

Day 2 – May 8th, 2014		
09:00	WP Parallel Sessions	
10:30-11:00	Coffee Break	
11:00	WP Parallel Sessions	
12:30-13:30	Lunch	
13:30	WP Parallel Sessions	
15:00	Closing Session – Discussion of outcomes and next steps	

Annex II: List of Participants

Name / Surname	Partner No	Partner Name
Nurcan Meral Ozel	1	KOERI
Ocal Necmioglu	1	KOERI
Meral Marina Alguadis	1	KOERI
Hayrullah Karabulut	1	KOERI
Dogan Kalafat	1	KOERI
Can Zulfikar	1	KOERI
Karin Sesetyan	1	KOERI
Ahu Mutlu	1	KOERI
Mehmet Yilmazer	1	KOERI
Semih Ergintav	1	KOERI
Mustafa Comoglu	1	KOERI
Süleyman Tunç	1	KOERI
Heiko Woith	2	GFZ
Louis Geli	4	IFREMER
Paolo Favali	5	INGV
Franco Italiano	5	INGV
Stefano Salvi	5	INGV
Alessio Piatanesi	5	INGV
Gabriella Giovanetti	5	INGV
Salvatore Stramondo	5	INGV
Daniela Pantosti	5	INGV
Aybige Akinci	5	INGV
Francesco Frugoni	5	INGV
Paola Mateira	5	INGV
Asım Oguz Ozel	6	IU
Esref Yalcinkaya	6	IU
Ziyadin Cakir	8	ITU
Mariarosaria Manzo	9	CNR-IREA
Manuela Bonano	9	CNR-IREA
John Douglas	10	BRGM
Hideo Aochi	10	BRGM
Thomas Ulrich	10	BRGM
Pierre Henry	12	CNRS
Pascal Bigarre	13	INERIS
Fiona Theoleyre	13	INERIS
Caroline Etivant-Detancourt	15	EMSC
Roberto Cossu	16	ESA
Paolo Gamba	16	ESA
Francesco Zucca	17	UNIPV
Salvatore Martino	18*	La Sapienza
Cansun Guralp	19	GURALP
Marco Zora	20	DAIMAR
Fabio D'anca	20	DAIMAR
Alessio Cantone	21	Sarmap