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THE EU SCHEMA PROJECT – BULGARIAN PARTICIPATION

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Abstract: *This presentation aims to familiarize the broad audience with the participation of the Bulgarian scientific institutions in the EU SCHEMA Project. SCHEMA is the acronym of Scenarios for Hazard-Induced Emergencies Management - Contract No: 030963 with the EU under the FP6 Priorities (Space). The Project comprises 2 general working packages, its duration is 36 months and it has 12 partner organizations from France, Portugal, England, Italy, Greece, Morocco, Turkey and Bulgaria.*

Recently, two very important new and unexpected evidences about the tsunami impact on the Bulgarian Black Sea coast have been obtained and investigated – the 7th May 2007 event and the discovery of the Cybele Temple in Balchik same year. The future activities, information dissemination and end-user requirements will be incorporated in the near future actions and investigations according to the Project's time schedule.

1. Bulgarian experience on Tsunami investigations in the Black Sea

The continuous research of the Black Sea tsunamis started in Bulgaria at the early 80-ies of the XX century creates interest and curiosity in the scientific community abroad. The first publications indicated that the Black Sea tsunamis are possible phenomena [1] have been followed by the participation of the Bulgarian specialists in the GITEC Project of EU (1992–1995) [2]. During the execution of this project many new and unknown facts about the observed and supposed tsunamis in the Black Sea and have been discovered the tsunami research in Bulgaria has been developed in different directions:

- New data and homogeneous catalogue (as part of the standardized GITEC catalogue) has been compiled [3];
- Tsunamigenic sources and natural vulnerable areas have been outlined [4,5];
- Ray refraction analysis and tsunami energy dissipation/concentration have been performed for the whole Black Sea area;
- Special vulnerability analysis has been performed for some areas and test site areas [6,7];
- Fractal properties of the tsunami in the Black Sea according the bottom and coastal geometry [8];
- First attempts of the tsunami zoning for the whole Black sea at large scales and in case of not completed information have been executed and rough schemes created, assessing the expected average run-ups and attack velocities of the tsunami to the shore, based on the average repeated recurrence time established by the real data [9,10,11,12,13,14];
- Original equipment about the tsunami laboratory generation and physical modelling investigations has been patented [15,16];
- Paleotsunami deposits have been discovered for the first time on the Black Sea coast [17,18].

2. SCHEMA Project

SCHEMA is the acronym of the Scenarios for Hazard-Induced Emergencies Management Contract No: 030963 with EC of the PF6 Priorities (Space). Duration – 36 months, 12 partner organizations from France, Portugal, England, Italy, Greece, Morocco, Turkey and Bulgaria.

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The Project is constructed by several working packages (WP's):

- the first one is related to the Lessons learnt by the previous experience and modeling possibilities and vulnerability analysis

- Other WP's include several (5 test site areas – **Morocco:** Rabat region; **Bulgaria:** Varna region on Black sea; **France:** Mandelieu, Cote D'Azur; **Portugal:** Setubal; **Italy:** Catania, Sicily), where different methodologies about tsunami modeling and vulnerability assessment well be performed. The main tasks of the Project is to satisfy the end-users requirements about the possible prevention and protection actions to the population of the threaten test sites.

- The last WP's are related to the management of the Project and the dissemination of the results obtained - Large knowledge exchange and massive people information is intended to the final stage of the project (Workshops, educational materials to the decision makers and the public, mass media involvements, etc.)

The WP 1 considers several topics important for the next works performance:

- State of the art of the partners' knowledge about tsunami;
- Lessons learned from December 2004 tsunamis and more recent events;
- Users' needs analysis;

- Collection of feed back on modelled effects in Indian Ocean. New modelling in some selected sites in Indian Ocean area;

- "Benchmark" of models compared to real damages. What the models do and what they do not do?;

- Generic factors to classify coast configurations and morphology (from the beaches and shores inland).

3. Bulgarian participation

The Bulgarian participation in the SCHEMA is represented by the Space Research Institute (SRI) which is a partner to the Project. Specialists with different abilities from different (outside SRI) organizations: GFI (Geophysical Institute at he Bulgarian Academy of Sciences, SWU (South-western University – Blagoevgrad), PLD (Plovdiv Geophysical Observatory, CDA (Civil Defence Administration), etc. playing important role in the Project. The initial items definition (test-site area, data and catalogues (earthquakes, surface and underwater landslides as possible triggers of tsunami), data bases, space images, etc.), end-users requirements and research activities intended are parts of the Project.

4. Working packages tasks and deliverables

The main focus at the initial phases of the project is related with the state of the art of the knowledge, lessons learnt and the assessment of the vulnerability criteria for future applications. The compilations of the seismic catalogues, landslides with different sizes and origin, their transformation in useful and homogenous data bases have been performed. The scenario definition, the data and imaginary collection and the tsunami hazard assessment are the targets of primary importance. Due to the former and resent analysis the main tsunami events are described as case studies and assessed by the recent terms of tsunami intensity (for the first time in the Bulgarian tsunami practice):

5. Case studies

I-st (III-rd?) century BC case – IX-X tsunami intensity (Papadopoulos-Imamura (P-I) scale)

"Ancient town Bisone (Greek colony) sank in the sea waters" (Strabo). Major earthquake (M ~ 8), accompanied by huge slides and large inundation (probably tsunamis). "The whole" ancient city (most probable – the port and the facilities) went under water. The rest part of the town was moved on the top hills. Paleotsunami findings.

543AD case – VII tsunami intensity (P-I scale)

Earthquake (M ~ 7.5), probable local tsunami, activated landslides, destroyed and buried the Cibele temple. Possible paleotsunami findings.

31st March 1901 earthquake and tsunami – V tsunami intensity (P-I scale)

Earthquake of magnitude M = 7.1 occurred in the sea. Large destruction in the epicentral area (more than 5 villages and small towns have been affected; more than 830 houses damaged.). Aftershock sequence lasted more than 7 years. Land subsidence and landslides (probably submarine as well) occurred. Rockfalls were reported. A witness reported a sea level rise of about 3 meters at the port of Balchik, recognized as tsunami.

The case of 7th May, 2007 – V tsunami intensity (P-I scale)

Northeast Bulgarian coast – nonseismic origin (possible underwater turbidities). Data about withdrawal and inundation – frequency of the phenomena (up 3–5 to 6–8 minutes) are collected. Data about the water peculiarities consequences – observed turbulences, currents and water boiling supports the used models. Data about the consequences – moved boats, tetrapodes and other items also have been assessed [19].

The systematic data of the parameters of these events are presented in [20].

The intended scenario earthquake has the following parameters:

Epicenter location: 43,2E; 28,6N; Depth-15; Epicentral intensity – X EMS; Magnitude: 7.2; Vertical displacement: 2–3 meters; Strike: E-W (1st variant) and NE-SW (2nd variant). This scenario is based on the event of 1901 as best studied earthquake and its consequences.

The formulation of the vulnerability criteria following the IADB methodology is the next important task of the test-site activity and assessment.

During the last years some new developed methodologies have been tested for the North Bulgarian Black Sea coast. The IADB methodology needs a special scheme about the factors and indicators recognition. After our research and investigations we developed and accommodated the indicators tables, which contains data and information about the main indicators and factors for vulnerability assessment [21, 22].

New evidences in 2007: The 7th May tsunami and Cibele temple discovery in Balchik

Unexpectedly, two new cases, extremely interesting and very important evidences about the tsunami influence occurred during 2007:

Tsunami observed on the North Bulgarian Black Sea coast on May, 7th 2007

About a three meters water level changes of nonseismic origin occurred on 7th May, 2007 on the North Bulgarian Black Sea coast with maximum effects around 12 LT. The starting time of the event was announced around 9-10 AM. The water oscillations have been observed several times, with long lasting fluctuations (between 10 and 15 cycles with decreasing intensity). The oscillation period was estimated about 3-4 minutes. In most cases water first withdrew and then the sea level rose in many areas on the North Bulgarian Black Sea coast. Observations have been made mostly in the two biggest towns of the coast – Balchik and Kavarna (about 13000 inhabitants each). The port authorities informed about similar effects to the North – near Kaliakra cape and village Shabla. According to the seismic network centre in Bulgaria, no significant earthquakes were recorded in the same day. Further, the weather conditions were normal and the sea was calm.

Fortunately, only slight negative effects occurred on the affected areas. The board of a tourist boat of 50-60 tons was damaged near the anchor holes and in some other parts as well as on the rule of the boat. This boat was rotated violently according to his captain. Many fishermen small boats sat on the sand. Debris was deposited on the coast. Three - four big tetrapodes (1.2 tons each) have been slightly moved from their previous positions near the port breakwater wall of the Kavarna town. Fortunately a lot of visual information has been collected – pictures, video clips, etc.

Probably the event was triggered by the underwater sliding of deposited masses. The fact that the water first receded from the usual shoreline is also in support of the slide origin. The observed turbulences registered on photo pictures and the muddy waters in the bay support that hypothesis further on. There is a possibility of the performance of the high resolution bottom deposits investigations.

The Cibele temple discovery – a evidence of multihazard destructive event

The discovered temple of the ancient goddess – Cibele – near Balchik in 2007, provoked the investigations about the possible reconstruction of the end of active life of the ancient temple. The temple is dedicated to one of the most popular cults during the ancient times and the possible reasons of those final moments of the temple activity.

After the ruins have been digged several possible explanations about the end times of this temple were suggested:

- possible destruction by unknown conquerors
- possible destruction by natural hazards
- Possible destruction by both factors.

Our research on the ruins and discovered artifacts leads at most to the second hypothesis – the destruction by a combination of several disastrous events acting during the ancient times. The

main role in this natural acting forces destroyed the ancient temple is a tsunami influence [23]. this fact is supported by the most of the discovered evidences preserved since the ancient times.

The most logic chain of destructive events destroyed the ancient temple looks like that.

- Burning phase. Possible fire of the roof could be trigger by the burning rituals, earthquake which cold trigger fire from the hall of the temple to the roof, etc. It seems clear that the roof (probably build up of wood) burned and collapsed on the floor. This hypothesis is supported by the black layer and the red bricks found on the floor. The time of the fire is not possible to be identified.
- Very soon after the fire, the floor had been flooded by sea water bringing the sand and shells. The sand comes from the sea and has typical sea origin. The grains, composition of the sand and the well preserved parts of the shells of mollusks support this hypothesis.
- It is very probable that this local tsunami had been generated by an earthquake. The list of known earthquakes leads to that one in 543 AD [20]. The effects of this earthquake could be the cracks visible on the walls on East and South segments. The fallen and broken marble plate with the written description is fully reconstructed – no missing parts, which means that this plate fall down and have been broken at once, and then immediately buried.
- Than the whole temple had been buried under the layer of deposits, also brought at once, because the whole lower part of the temple with the artifacts and the walls are preserved totally. The most probable explanation is that this burial process is due to the landslide or some not very fast, but also not very slow process (like erosion depositions for example). That's why these parts (from the walls and the marble and) have not been used for some kind of further structures construction around the temple (as the ancient practice is). The buried process had been enough fast to preserve the walls and artifacts, and not enough slow to the same reason. The only natural process with such physical characteristics could be the landslide, which also added its force for the mixture of the artifacts inside the space of the temple. The area is famous with active landslides with Pleistocene age and the materials inside the temple are absolutely similar to the surrounding materials sliding down permanently.

This hypothesis is still under development and verification. The archeological diggings process is in prolongation. The new discoveries are expected in the near future.

Horizontal links

During the execution of the SCHEMA project, other tsunami EU projects started (like TRANSFER, Sea HELARC etc.). The horizontal links between all these projects have been established by participation of some partners in the other projects. For example: the team from Bologna University and National Observatory of Athens participated in all mentioned projects, the JRC team and B. Ranguelov from Bulgarian Academy of Sciences – in TRANSFER and SCHEMA, etc. The new developed methodologies by different teams for tsunami modeling and tsunami hazard assessment have been performed on different test site areas (for example – to the North Bulgarian Black Sea coast). The fruitful cooperation started between the teams. The mobility and free exchange of specialists' ideas, data and information have been performed between the partners in the European Research Area (ERA). New links and future cooperation is intended in the frame of SCHEMA, TRANSFER and other projects. Workshops, meetings, research exchange is planed for the next months related to the execution of SCHEMA. All actions are targeted to the requirements satisfaction of the end users and for the benefits of the research and investigations to the societies, local administrations and Civil Defense activities.

Conclusions

The main purposes of the SCHEMA project are outlined and described in the frame of the Bulgarian tsunami investigations experience.

The main achievements of this experience are summarized and systematically incorporated during the initial phase of the project.

Two very important new and unexpected evidences about the tsunami influence to the Bulgarian Black Sea coast happened and have been investigated recently.

The future activities, information dissemination and end-users requirements will be incorporated in the near future actions and investigations according the Project time schedule.

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