Long-term monitoring of earthquake precursor phenomena

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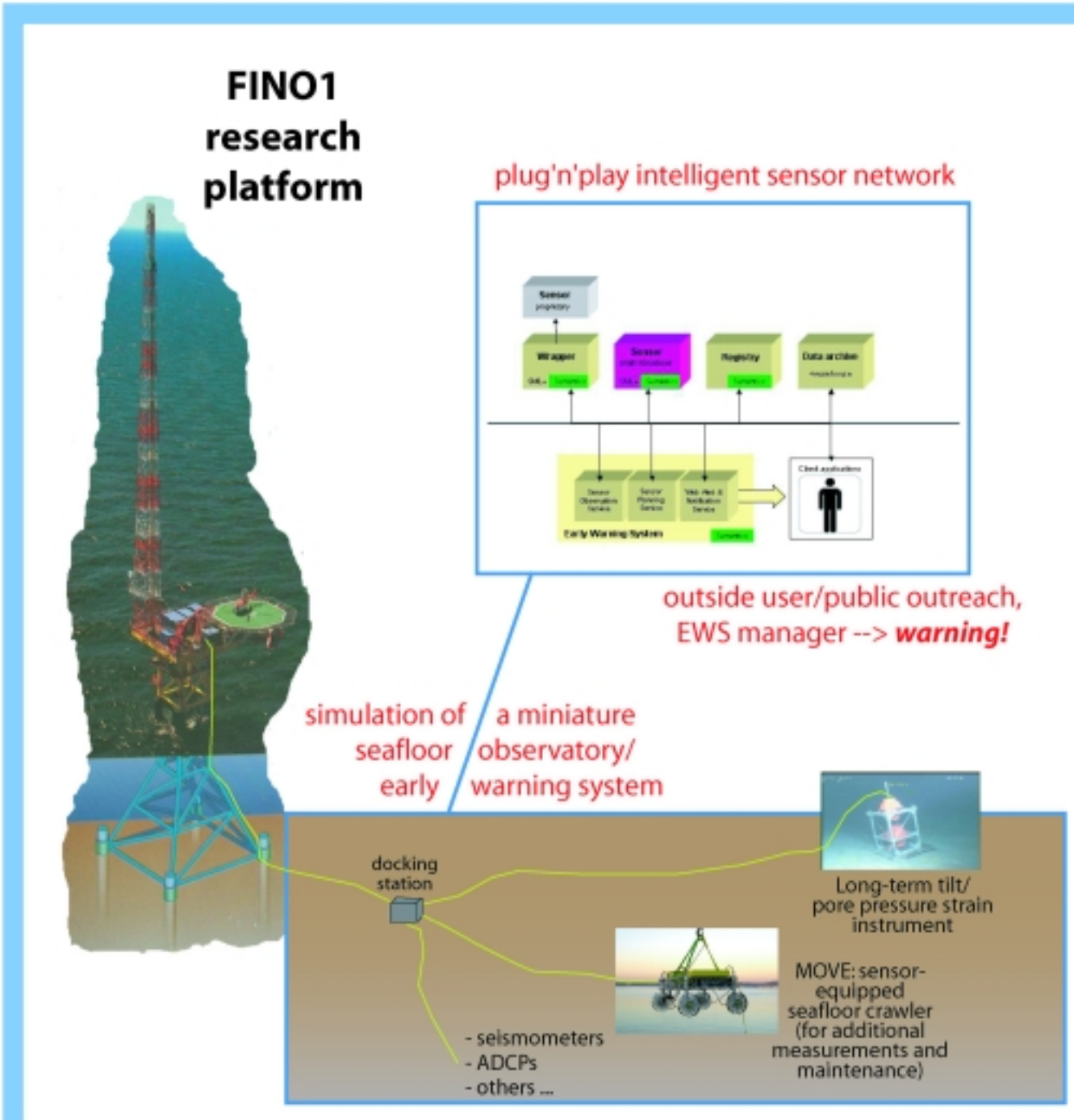
Scientific Rationale:

It is known since Hubbert & Rubey's benchmark paper (1959) that fluids play an important role in faulting. Later on, in situ measurement across fault zones attested that pore pressures have significant impact on reducing effective frictional stresses, with peak values exceeding the lithostatic load (Moore & Saffer, 2001). Fluid flow events through permeable fault zones have been reported during major earthquakes, and the stress change at seismogenic depth may be transferred to the surface.

As a consequence, shallow burial of high-resolution pressure sensors is a powerful means to monitor earthquake precursors. This has been successfully carried out in onshore settings such as the Caucasus orogenic complex, where anomalously high pore fluid flux preceded regional earthquakes by several hours to days (Kopf et al., 2005). Real-time monitoring of that parameter is a reliable measure for pre-seismic stress variation, and would ultimately allow EWS-managers to take measures if pressure transients are indicative of an upcoming hazardous event.



Approach:

In order to simulate a network of underwater stations measuring precursor phenomena such as pore pressure transients or tilt, we install an ocean bottom docking station plus an *in situ* instrument near the FINO1 research platform in the North Sea. The location is ideal since it insures continuous power supply, real-time data transfer to shore, and a suite of scientific and governmental users in the seafloor, water column, and air.

We collect and time-stamp data from this multi-disciplinary, and relate the pore pressure changes to platform movement, storm and tidal loading, etc. This way we simulate both a seafloor observatory (including sensor/instrument interoperability and data management) and an early warning system (real-time strain monitoring, long-term sensor drift).

With this generic approach, which chiefly focuses on a "source to sink " approach, we cover *in situ* precursor measurement, data management and archiving all the way to setting the criteria for alerts.

Summary & Outlook:

With a shallow-water platform simulating a submarine EWS, we ensure
- real-time monitoring of earthquake precursor phenomena *in situ*,
- intelligent sensors in a plug'n'play network of multiple intruments and users (government, academia, industry)
- a test bed for long-term instrument drift and reliability.

Approved instruments will then be fed into deep-sea EWSs and seafloor observatories within ESONET (European Seafloor Observatory NETwork), NEPTUNE, or IODP initiatives. Studying earthquake precursors here seems more powerful than installations dealing with their consequences (e.g. tsunamis). The first deep observatory is at the Ligurian Margin, Western Mediterranean Sea, using broadband OBSs together with pore pressure instruments.

References:

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