## Project Title
Response of the Gulf of Guinea coastline to a multi-scale oceanic forcing: from event to climatic variability.

### Years
2013 – 2014

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### Participating Laboratories:
- EPOC, CEREGE, LDO-IUEM, LYON1, Plymouth Univ, Bath Univ.

### Objectives
Improve our understanding on sandy tropical coastlines, which remained rather of the scope of past studies and represent now a challenge in the rapid socio-economical development of the concerned countries.

### Main Results
Storm free low lying sandy Gulf of Guinea coastline is currently eroding at an unprecedented rate, peaking at 10 m/yr at Cotonou. Main cause of erosion has anthropic origin and results from recent harbour dikes which perturb one of the largest longshore sediment drift in the world.

### Achievements
With the aim of monitoring the coast at multi-scale, from short event scale to long seasonal to interannual scale, a video station was installed at Grand Popo, Bénin. A very complete determination of the nearshore system can be obtained: waves, tide/setup, surface currents, bathymetric inversion and intertidal topography/shoreline. The system was installed at the beginning of the Grand Popo 2013 experiment (Almar et al., 2014). This experiment aimed at better describing dominant processes, at short term scale, and validating video system remote methods. A second experiment has been conducted in 2014 with extended consortium and instrumentation.

### Hydro-morphodynamic processes
Measurements showed one the largest wave reflection (30%) worldwide, linked to the swash dynamics which acts as a low-pass filter (Almar et al., 2014; 2015). Linking offshore wave conditions with upper beach morphodynamics, Senechal et al (2014) shows that contrary to previously observed elsewhere, beach cusps system can form during both accretion and erosion transitions. Castelle et al. (2014) provides a new description of flash rips activity, crucial for cross-shore exchanges and mixing between surf zone and inner shelf, which origin is still under debate (intrinsic current instability versus extrinsic group of individual breaking wave forcing). Using a combination of 3D-numerical modeling Marchesiello et al., (2015) shows the importance of longshore current instability. Through a new method for deriving surface current from video, Almar et al., (2015) shows that longshore current is differently controlled by wind, waves, and tide, respectively at the inner shelf, surf and swash zones.

### Multi-scale coastal variability, origin and shoreline response
In order to better understand the scales of coastal variability and associated erosion, a multi-scale study was performed using 30-yr available hindcast. Almar et al., (2015) shows that waves hitting the coast and at the origin of the strong littoral drift are generated in 3 zones, South West Atlantic westerlies, South East trade winds and local winds in the Gulf of Guinea. Swell-wave induced drift is strongly dependant on Southern Antarctic Modulation (SAM) regional climatic mode, whereas wind-wave induced drift is mostly controlled by Inter Tropical Convergence Zone (ITCZ) modulation. Melet et al. (2015) shows that waves contribute for ~30% of total interannual shoreline sea level whereas extreme events are dominated by waves.
a) Net annual longshore sediment transport in the Bight of Benin induced by waves. Yellow rectangle stands for transport convergence region. b) Interannual variation of the net annual longshore sediment transport at Cotonou induced by swell (red) and wind waves (blue). Dashed line shows trend over the period.

Future of the project:
This exploratory project has initiated several new collaborations and projects and has started to structure the nearshore research community in West Africa. The ANR COASTVAR (PI R. Almar 2015-2018) on nearshore multi-scale variability in Vietnam and West Africa beneficacits directly of the consortium and experience. The Laboratoire Mixte International (LMI) ECLAIRS will gather climate/oceanographic research and education projects in West Africa. The Jeune Equipe Associée à l’IRD JEAI (2015-2018) will federate efforts of nearshore studies in the Gulf of Guinea. Finally, one of the main outreach is the recently created West Africa Coastal Observatory (MOLOA CSE/Dakar, MOLOA), that federates observation and actions in West Africa. 14 video stations are currently deployed at focal points from Mauritania to Benin, based on the feasibility offered by the pilot site of Grand Popo, Benin.

Nombre de publications, de communications et de thèses

Journal paper: 5 published, 3 submitted, 3 in prep
Conference proceedings: 5
Master students: 6
2 PhDs: D. Angnuureng (2013>), Univ Bordeaux/LEGOS/Univ Ghana, G. Degbe (2012>), Univ Abomey Calavi, Benin

5 publications maximum:
Patrick Marchesiello, Rafael Almar, Rachid benshila, Stanislas Larnier, Bruno Castelle and Raoul A. Laibi. 2015. Eddy mixing of longshore currents: video observation and 3D modeling of Grand Popo beach, Benin, to be submitted to Geophysical Research Letters