Committee on Earth Observation Satellites

COAST Study Team

# Annotated Bibliography Phase 1

**September 6, 2020**

(Focus areas listed alphabetically by first author)

## Pilot-Specific Backgrounds

### Sea Impacts to Land

***Framework to derive valid satellite-derived bathymetry (SDB) over moderately turbid environments by using the high revisit time (5-day) of the Sentinel-2A/B twin mission from the Copernicus programme. The proposed methodology incorporates a robust atmospheric correction, a multi-scene compositing method to reduce the impact of turbidity, and a switching model to improve mapping in shallow water. Two study sites in the United States are explored due to their varying water transparency conditions.***

Caballero, Isabel and Richard P. Stumpf. 2020a. Towards Routine Mapping of Shallow Bathymetry in Environments with Variable Turbidity: Contribution of Sentinel-2A/B Satellites Mission. Remote Sensing 12, 451.

***Different atmospheric correction (AC) procedures for Sentinel-2 satellites are evaluated for their effectiveness in retrieving consistent satellite-derived bathymetry (SDB) over two islands in the Caribbean (Buck and Culebra).***

Caballero, Isabel and Richard P. Stumpf. 2020b. Atmospheric correction for satellite-derived bathymetry in the Caribbean waters: from a single image to multi-temporal approaches using Sentinel-2A/B. Vol. 28, No. 8 / 13 April 2020 / Optics Express 11742

***Examines the relatively high-resolution MultiSpectral Instrument (MSI) onboard Sentinel-2A and 2B for generating bathymetric maps through a ratio transform model in South Florida (United States). Atmospheric correction of imagery is implemented through ACOLITE software.***

Caballero, Isabel and Richard P. Stumpf 2019. Retrieval of nearshore bathymetry from Sentinel-2A and 2B satellites in South Florida coastal waters. Estuarine, Coastal and Shelf Science 226: 106277

***Summary of historical shoreline change trends since 1984 and methodology for the same.***

Luijendijk, Arjen, Gerben Hagenaars, Roshanka Ranasinghe, Fedor Baart, Gennadii Donchyts & Stefan Aarninkhof. 2018. State of the World's Beaches. SCIENTIFIC REPORTS | (2018) 8:6641 | DOI:10.1038/s41598-018-24630-6

***Concludes changing flooding regimes are the result of multiple interacting social-ecological processes associated with the expansion of rubber and oil palm plantations in Jambi Province. Although ecohydrological changes are likely to contribute to an increase of flood occurrence, their social impacts are increasingly mediated through flood control infrastructure on industrial oil palm plantations.***

Merten, J., C. Stiegler, N. Hennings, E. S. Purnama, A. Röll, H. Agusta, M. A. Dippold, L. Fehrmann, D. Gunawan, D. Hölscher, A. Knohl, J. Kückes, F. Otten, D. C. Zemp, and H. Faust. 2020. Flooding and land use change in Jambi Province, Sumatra: integrating local knowledge and scientific inquiry. Ecology and Society 25(3):14. https://doi.org/10.5751/ES-11678-250314

***A method to analyse the temporal evolution of residential population exposure to coastal flooding.***

Stevens, AJ, D. Clarke , R. J. Nicholls , and M. P. Wadey. 2015. Estimating the long-term historic evolution of exposure to flooding of coastal populations. Nat. Hazards Earth Syst. Sci., 15, 1215–1229, 2015 www.nat-hazards-earth-syst-sci.net/15/1215/2015/ doi:10.5194/nhess-15-1215-2015

***An early algorithm for Satellite-derived Bathymetry.***

Stumpf, Richard P. and Christine Holdereid. 2003. Determination of water depth with high-resolution satellite imagery over variable bottom types. Limnol. Oceanogr., 48(1, part 2), 547–556.

***Whitepaper on the plans for WGDisasters Flood Pilots 2019-2022.***

CEOS Flood Pilot Overview. August 17, 2020. Mitch Goldberg.

***Whitepaper on the WMO plans for measuring Satellite-Derived Coastal Bathymetry.***

Satellite-Derived Coastal Bathymetry, CGMS-47 WMO-WP-13 V1, 18-04-2019, Prepared by WMO Agenda Item: 8 Discussed in WGII.

***Summary findings and recommendations of GEBC), an international group of experts whose aim is to provide the most authoritative publicly available bathymetry of the world's oceans, for scientific and educational use.***

International Hydrographic Organization, Intergovernmental Oceanographic Commission, The IHO-IOC GEBCO Cook Book, IHO Publication B-11, Monaco, Dec. 2015, 429 pp – IOC Manuals and Guides 63, France, Dec. 2015, 429 pp.

# Land Impacts to Sea

***SAR Processing.***

Gan, Lu, Xiaoming Liu and Ziwei Li. 2018. Unsupervised SAR image segmentation based on kernel TMFs with belief propagation. The Journal of Engineering.

***Satellite remote sensing now offers the possibility of monitoring surface water stocks by using the complementarity between multispectral imagery, allowing to map flooded areas, and the radar altimetry providing time series of water depths of continental hydro systems. Thesis utilizes different types of spatial observations to evaluate the water resources of the surface reservoir and to measure the dynamics of water transfers between land and ocean, and its impact on the coastal zone using suspended particulate matter as tracer of water bodies.***

Normandin, Cassandra. 2019. Contribution of high resolution spatial remote sensing for the study of surface water cycles and suspended particulate matter along the watershed-coastal ocean continuum. Thesis. University of Bordeaux.

***Ocean Color Methodology and considerations in coastal areas.***

Wang. 2007. Remote sensing of the ocean contributions from ultraviolet to near-infrared using the shortwave infrared bands: simulations. Applied Optics. Vol. 46, No. 9: 1535-1547.

***A physics-based approach is introduced for depth retrieval from multi-spectral data, which leverages the temporal variation in satellite image data, and can improve depth retrievals greatly with multi-spectral ocean color spectra.***

Wei, Jianwei, Menghua Wang, Zhongping Lee, Henry O. Briceño, Xiaolong Yu, Lide Jiang, Rodrigo Garcia, Junwei Wang, and Kelly Luis. 2020. Shallow water bathymetry with multi-spectral satellite ocean color sensors: Leveraging temporal variation in image data. Remote Sensing of Environment Volume 250, 112035.

## Technology Needs

***Discusses the potential benefits of using SARAL/AltiKa data to provide improved observations of coastal regions. The use of the data from SARAL helps to better estimate low wave heights, which is important for coastal regions during non-monsoon seasons in east India. Its use for near shore measurements of wave attributes may prove extremely useful when looking for near real time estimates of wave height.***

Acharyulu, PSN, Prasad KVSR, Vignidelli Stefano and Rashmi Sharma, 2018. Potential use of SARAL/AltiKa towards coastal regions – A case study on the East coast of India.

Modern Approaches in Oceanography and Petrochemical Sciences, doi:10.32474/MAOPS.2018.01.000120.

***Examines 15 years (1993–2007) of satellite altimeter and coastal tide-gauge records in the Bay of Bengal and demonstrates that satellite altimetry can be a useful complementary dataset for the study of storm surges.***

Antony, Charls, Laurent Testut and A.S. Unnikrishnan, 2014. Observing storm surges in the Bay of Bengal from satellite altimetry. Estuarine, Coastal and Shelf Science, http://dx.doi.org/10.1016/j.ecss.2014.09.012

***Discusses the main forcing agents on coastal regions and the induced coastal response. Identifies a number of observational needs to be addressed in the near future to understand coastal zone evolution including monitoring coastal sea level by satellite altimetry techniques, which is explored in detail. Presents a new promising technology based on the use of Signals of Opportunity (communication satellite transmissions that are reutilized as illumination sources in a bistatic radar configuration, for measuring coastal sea level.)***

Benveniste, Jerome, Anny Cazenave, Stefano Vignudelli, Luciana Fenoglio-Marc, Rashmi Shah, Rafael Almar, Ole Andersen, Florence Birol, Pascal Bonnefond, Jérôme Bouffard, Francisco Calafat, Estel Cardellach, Paolo Cipollini, Gonéri Le Cozannet, Claire Dufau, Maria Joana Fernandes, Frédéric Frappart, James Garrison, Christine Gommenginger, Guoqi Han, Jacob L. Høyer, Villy Kourafalou, Eric Leuliette, Zhijin Li, Hubert Loisel, Kristine S. Madsen, Marta Marcos, Angélique Melet, Benoît Meyssignac, Ananda Pascual, Marcello Passaro, Serni Ribó, Remko Scharroo, Y. Tony Song, Sabrina Speich, John Wilkin, Philip Woodworth and Guy Wöppelmann. 2019. Requirements for a Coastal Hazards Observing System. Frontiers in Marine Science, 17 July 2019 | https://doi.org/10.3389/fmars.2019.00348

***Recent Open Data Cube work in Australia looking at characterizing the intertidal zone and better representing the land/sea interface at a continental scale.***

Bishop-Taylor, R., Sagar, S., Lymburner, L., Beaman, R.J., 2019. Between the tides: Modelling the elevation of Australia's exposed intertidal zone at continental scale. Estuarine, Coastal and Shelf Science 23, 115–128. https://doi.org/10.1016/j.ecss.2019.03.006

***In this study, we present a comprehensive evaluation of a promising method for mapping waterlines at sub-pixel accuracy from satellite remote sensing data…discuss key challenges and limitations associated with selecting appropriate water indices and thresholds for sub-pixel waterline extraction, and suggest future directions for improving the accuracy and reliability of extracted waterlines.***

Bishop-Taylor, R., Sagar, S., Lymburner, L., Alam, I., Sixsmith, J., 2019. Sub-Pixel Waterline Extraction: Characterising Accuracy and Sensitivity to Indices and Spectra. Remote Sensing 11, 2984. https://doi.org/10.3390/rs11242984

***In this study, data from space-based altimeters (Jason-2 and Satellite for ARgos and AltiKa [SARAL/AltiKa]) have been used to compute alongshore geostrophic currents in the coastal regions of the Indian mainland. Satellite-derived across-track geostrophic current components (alongshore current) were also used to study the spatiotemporal variations of the east India coastal current.***

Chaudhary, Aditya, Neeraj Agarwal, Rashmi Sharma, B. K. Jena & Raj Kumar, 2019, "Coastal currents from Jason-2 and SARAL/AltiKa in the Indian region", International Journal of Remote Sensing, DOI: 10.1080/01431161.2019.1602793

***Reports the findings of a study using a five-parameter model, BETA5, to derive significant wave height using 20-hz Jason-2/OSTM Ku band waveforms in the Bay of Bengal. The study shows standard maximum likelihood estimator retrackers are not appropriate for retracking nontraditional waveforms.***

Chaudhary, Aditya, Sujit Basu, Raj Kumar, K.V.S.R. Prasad & Rashmi Sharma, 2015, "Retrieving significant wave height in the Indian Ocean near Visakhapatnam using Jason-2 altimeter data, Remote Sensing Letters, 6:4, 286-294, DOI: 10.1080/2150704X.2015.1029091

***Details the shape classification of 40-hz waveforms to be used in adjusted retracking algorithms for echoes from the coastal ocean. This shape classification strategy is necessary for classifying waveforms into various categories.***

Chaudhary, Aditya, Sujit Basu, Raj Kumar, C. Mahesh & Rashmi Sharma, 2015, "Shape Classification of AltiKa 40-Hz Waveforms using Linear Discriminant Analysis and Bayes Decision Rule in the Gujarat Coastal Region", Marine Geodesy, doi:10.1080/01490419.2014.1001504, online 22 Jan 2015

***Summarizes aquifer and groundwater quality risks from climate change and especially sea-level rise in coastal areas, including changes in human use.***

Ferguson, Grant and Tom Gleeson, 2012. Vulnerability of coastal aquifers to groundwater use and climate change. Nature Climate Change, Volume 2: 342-245. DOI: 10.1038/NCLIMATE1413

***Discusses a technique to obtain significant wave heights at a specific coastal site from their values gathered by a satellite at deeper location. The technique is based on the approach of Artificial Neural Network (ANN) of Radial Basis Function (RBF) and Feed-forward Back-propagation (FFBP) type.***

Hamilton, S.E., 2019, Mangroves and Aquaculture: A Five Decade Remote Sensing Analysis of Ecuador's Estuarine Environments. *Mangroves and Aquaculture*.

***This paper discusses a technique to obtain significant wave heights at a specified coastal site from their values gathered by a satellite at deeper offshore locations. The technique is based on the approach of Artificial Neural Network (ANN) of Radial Basis Function (RBF) and Feed-forward Back-propagation (FFBP) type.***

Kalra Ruchi, M. C. Deo, Raj Kumar and Vijay K. Agarwal, 2005, "Artificial neural network to translate offshore satellite wave data to coastal locations", Ocean Engineering, Vol. 32, 1917-1932.

***Deep-water ocean gravity waves approaching the coasts revealed refraction processes. Wave parameters in deep and shallow waters, estimated through Fast Fourier Techniques, were interrelated through dispersion relationship to yield depth values near the coast.***

Kuenzer, Claudia, Andrea Bluemel, Steffen Gebhardt, Vo Quoc Tuan, Stefan W. Dech. 2011, Remote Sensing of Mangrove Ecosystems: A Review Remote. Sensing

***ERS-1 borne Synthetic Aperture Radar image data over Goa region of Indian west coast were analysed. On comparison with the charted depths, the remotely sensed depths were found to have less than 15% deviation on an average, indicating potential use of this technique for large area depth mapping and monitoring.***

Kumar, Raj, A Sarkar and P C Pandey, 1999, "Estimation of Ocean depths off Goa coast using ERS-1 SAR", Continental Shelf Research, Vol. 19, No.2, 171-181.

***Attempts to develop a methodology to predict ocean surface waves by assimilating data in open ocean wave models. This assimilation has been found to significantly improve the prediction of the height of wind waves and swell waves.***

Kumar, Raj, SA Bhowmick, S Ray, V Bhatt, S Surendran, Sujit Basu, A Sarkar and V K Agarwal, 2009, "Improvement in Predictability of Waves over the Indian Ocean", Natural Hazards, Volume 49, Issue 2, 275-291, doi:10.100/s11069-008-9310-y.

***The paper gives an overview of the development of satellite oceanography over the past five years focusing on the most relevant issues for operational oceanography. It also addresses the challenges for the next decade of satellite oceanography observing such as, continuity and reliability, resolution and coverage, and knowledge.***

LeTraon, P-Y et al 2015. Use of Satellite Operations for Observational Oceanography: recent achievements and future prospects. Journal of Operational Oceanography. 8 (S1): s12-s27

***Cyclone-induced coastal inundation along the east coast of India is simulated using the state-of-the-art advanced circulation model coupled with Simulating Waves Nearshore model. Bathymetry of the computational domain is prepared by integrating digital coastal bathymetric chart with global digital elevation model (DEM) ETOPO-2. Topography of the coastal land region is created by merging data from the fine resolution airborne DEM with that from the Indian satellite CARTOSAT-2 derived CARTO2 DEM and Shuttle Radar Topography Mission DEM. The major shortcomings of coastal inundation simulation due to inaccurate***

***representation of intricate networks of river, creeks and lagoons have been overcome by careful description of the critical coastal wetland features influencing the landward inundation of storm surge.***

Mandal, A.K., Ramakrishnan, R., Pandey, S., A.D. Rao, and Prashant Kumar.. 2020. An early warning system for inundation forecast due to a tropical cyclone along the east coast of India. *Nat Hazards* 103, 2277–2293. https://doi.org/10.1007/s11069-020-04082-w

***Describes the current state of remote sensing challenges to use satellite radiometry in coastal and inland waters. By addressing these challenges, the future desires, solutions, and recommendations for improving mission capacity, in situ observations, algorithm development, and operational capacity, are brought to the forefront.***

Mouw, CB et al 2015. Aquatic color radiometry remote sensing of coastal and inland waters: Challenges and recommendations for future satellite missions. Remote Sensing of Environment 160:15-30

***Discussion on satellite sensor requirements to effectively monitor Essential Biodiversity Variables (EBV's) in coastal environments….***

Muller‐Karger, F.E., et. al. 2018. Satellite sensor requirements for monitoring essential biodiversity variables of coastal ecosystems. Ecological Applications 28, 749–760. https://doi.org/10.1002/eap.1682

***Summarizes the impacts to small-island nations from climate change. Current and future climate-related drivers of risk for small islands during the 21st century include sea level rise (SLR), tropical and extratropical cyclones, increasing air and sea surface temperatures, and changing rainfall patterns.***

Nurse L, McLean R, Agard J, Briguglio L, Duvat‐Magnan V, Pelesikoti N, Tompkins E, Webb A. Small islands. In: Field CB , Barros VR , Dokken DJ , Mach KJ , Mastrandrea MD , Bilir TE , Chatterjee M , Ebi KL , Estrada YO , Genova RC , et al., eds. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge and New York, NY: Cambridge University Press; 2014, 1613–1655.

***Features results of a study using satellite altimeters that are assimilated into coastal wave models simulating waves nearshore operating in the Indian coastal waters. The report goes into specific techniques used to heighten the sensitivity of the altimeters including using modern particle filtering technique and joint assimilation of data from three different altimeters. The results obtained are encouraging for improving coastal wave forecasting.***

Suchandra Aich Bhowmick, Smitha Ratheesh, Rashmi Sharma, Sujit Basu & Raj Kumar, 2019, "A Simplified Assimilation Scheme for a Coastal Wave Model Using Concepts of

Particle Filter", Pure and Applied Geophysics, Online, Oct 23, 2019, DOI 10.1007/s00024-019-02343-9

***Analyzes the performance of sensitivity of the SWAN coastal wave model towards wind inputs and physics options over the Indian Ocean by forcing the model with analyzed GDAS winds. Indicates that the model with Janssen physics options simulates the significant wave height with a relatively high degree of accuracy.***

Suchandra A Bhowmick, Raj Kumar, Sutapa Chaudhuri, and Abhijit Sarkar, 2011, "Sensitivity Study of a Coastal Wave Model for Prediction of Ocean Waves over Indian Ocean Region", Marine Geodesy, 34: 2, 167-180. May 2011

***Focuses on different vulnerabilities to coast of India and one of the assessment methods, coastal vulnerability index methodology, applied throughout India. The vulnerability assessment is the process where the problems are identified, quantified, and the risk rate in forming development strategies to reduce the risk and vulnerabilities is assessed. This assessment is crucial to aid in coastal management efforts.***

Sudha Rani, N.N.V. A. N. V. Satyanarayana and Prasad Kumar Bhaskaran. 2015. Coastal vulnerability assessment studies over India: a review. Natural Hazards (2015) 77:405–428, DOI 10.1007/s11069-015-1597-x

***This case study uses the West Bengal region in India to understand different factors that are affecting the coast and influencing changes in coastal areas including: coastal erosion, inundation, saltwater intrusion, and increases in intensity of storms. The study aims to generate vulnerability risk maps for coastal regions using different satellite data sets to assess sea level rise and inundation.***

Sudha Rani, NNV, ANV Satyanarayana and Prasad Kumar Bahskaran. 2018. Impact of sea level rise and inundation due to tropical cyclone and west Bengal coastal area using remote sensing and GIS technique. EGU General Assembly, 2018.

***Explores the use of genetic algorithm instead of typical methods for predictions of tidal currents in the coastal region, such as harmonic analysis or numerical hydrodynamic models. Uses a multivariate version of genetic algorithms to carry out the forecasts.***

Remya P G, Raj Kumar and Sujit Basu, 2012a, "Forecasting tidal currents from tidal levels using genetic algorithm," Ocean Engineering, Vol. 40, 62-68, Feb 2012.

***Report highlights the results of a model hindcast of wave data in the offshore and coastal areas in the Indian Ocean using MIKE 21 SW Models. Models were validated using buoy and altimeter data.***

Remya P G, Raj Kumar, Sujit Basu and Abhijit Sarkar, 2012b, "Wave hindcast experiments in the Indian Ocean using MIKE21 SW Model, Journal Earth System Sciences, Vol. 121, No. 2, 385-392, April 2012.

***Explores the data behind an automated open-source approach to generate satellite-derived elevation data for over 15,000 km² of intertidal terrain across the Australian coastline.***

Sagar, S., Roberts, D., Bala, B., Lymburner, L., 2017. Extracting the intertidal extent and topography of the Australian coastline from a 28 year time series of Landsat observations. Remote Sensing of Environment 195, 153–169. https://doi.org/10.1016/j.rse.2017.04.009

***Describes a Model.***

Varma, A K, C M Kishtawal, Raj Kumar, P C Pandey and K P Singh, 1998, "Coastal wave transformation model for shallow waters", Indian Journal of Marine Sciences, Vol. 27, March 98, pp 76-81.

***Follows the outcome of a study from a mission using SARAL/AltiKA for Oceanography. The mission aimed to observe oceanic mesoscales, along with global and regional sea monitoring, including coastal zone, data assimilation, and operational oceanography. Compared to the standard Ku-band altimetry measurements, the Ka-band provides substantial improvements in terms of spatial resolution and data accuracy – other achievements of the mission in terms of scientific applications such as this are also highlighted in the paper.***

Verron, Jacques & Bonnefond, Pascal & Aouf, Lofti & Birol, Florence & Bhowmick, Suchandra & Calmant, Stéphane & Conchy, Tainá & Cretaux, J. & Gerald, Dibarboure & Dubey, Amit & Yannice, Faugere & Guerreiro, Kevin & Gupta, P. & Hamon, Mathieu & Jebri, Fatma & Kumar, Raj & Morrow, Rosemary & Pascual, Ananda & Pujol, Isabelle & Vergara, Oscar. 2018. The Benefits of the Ka-Band as Evidenced from the SARAL/AltiKa Altimetric Mission: Scientific Applications. Remote Sensing. 10. 163. 10.3390/rs10020163.

***Ocean color radiometry has the capacity to help establish water quality monitoring products, but there is a need for collaboration between optical oceanographers and environmental scientists. Additionally, the capacity of these products will only improve if more efforts are devoted to identifying optical, ecological, and environmental forerunners of autochthonous water quality issues, and if there is a better understanding environmental processes associated with the source, transport, and transformation of these issues.***

Zheng G and P. M. DiGiacomo 2015. Uncertainties and applications of satellite-derived coastal water quality products. Progress in Oceanography 159:45-72

# Capacity Building Needs

***Makes recommendations to promote observing systems aiming to address important issues in coastal ecosystems and ensure their sustainability. Highlights project using these approaches including the Land Ocean Interactions in Coastal Zone Project. Addresses challenges to the lack of capacity to implement observing systems.***

Christian, Robert. R. Paul M. DiGiacomo, Thomas C. Malone, and Liana Talaue-McManus. 2006. Perspectives in Estuarine and Coastal Science - Opportunities and Challenges of Establishing Coastal Observing Systems Estuaries and Coasts 29(5):871-875, Opportunities and Challenges of Establishing Coastal Observing Systems

***Addresses the necessity of stakeholder engagement in ocean observations, especially for the realization of economic and social benefits. Highlights the overarching principles guiding this discussion including convergence on common goals, effective communication, co-production of information and knowledge and the need for innovation.***

Mackenzie et al 2019. The role of stakeholders in creating societal value from coastal and ocean observations. Frontiers in Marine Science May 2019.

***Emphasizes the wide swath of multidisciplinary data needed to inform adaptive, ecosystem-based approaches for maintaining coastal ecosystem services based on comparative ecosystem analyses. Addresses the need for a global coastal network but also the need for it to be tailored regionally and locally based on priorities established by stakeholder representatives in those regions.***

Malone TC et al. 2014 A global ocean observing system framework for sustainable development. Journal of Marine Policy 43: 262-272

***Identifies the essential indicator variables required for the sustained provisions of frequently updated integrated ecosystem assessments (IEAs), and offers an approach to establishing a global network of coastal observations within the framework of the Global Ocean Observing System.***

Malone TC et al 2014 Enhancing the Global Ocean Observing System to meet evidence-based needs for the ecosystem-based management of coastal ecosystem services. Natural Resources Forum 38: 168-181

***A numerical model, XBeach, calibrated and validated on field data collected at Roi-Namur Island on Kwajalein Atoll in the Republic of Marshall Islands, was used to examine the effects of different coral reef characteristics on potential coastal hazards caused by wave-driven flooding and how these effects may be altered by projected climate change.***

Quataert, E., Storlazzi, C., van Rooijen, A., Cheriton, O., van Dongeren, A. The Influence of coral reefs and climate change on wave-driven flooding of tropical coastlines, *Geophysical Research Letters, 42, 15.* https://doi.org/10.1002/2015GL064861. Published 07 July 2015.

***Discusses human population dependency on marine ecosystems through a new conceptual model that maps the degree of dependence based on magnitude of benefit, susceptibility to loss of the benefit, and availability of alternatives, all for designing more effective large-scale management and policy interventions.***

Selig RS et al. 2018. Mapping global human dependence on marine ecosystems. Conservation Letters 2018e12617

***Reports the outcomes of the 2018 Understanding Flooding on Reef-lined Island Coasts Workshop. The report highlights three topics that emerged from the meeting that have led to further development of a project related to wind-wave driven flood forecasting. The three topics were: the need for early-warning capabilities to provide forecasts of flooding, the need to begin developing predicted scenarios of flooding that start a few decades into the future, and the greatest needs for developing these tools include mapping island topography and coral reef bathymetry.***

Storlazzi, C. D. (2018), Challenges of forecasting flooding on coral reef-lined coasts, *Eos, 99,* https://doi.org/10.1029/2018EO098517. Published on 16 May 2018.

***Extends on the CEOS 2017 feasibility study for an aquatic EO system…***

CEOS. 2017. A. G. Dekker and N. Pinnel, editors. Feasibility study for an aquatic ecosystem Earth observing system. Report v. 1.1. Committee on Earth Observation Satellites (CEOS) and Commonwealth Scientific and Industrial Research Organization (CSIRO). CSIRO, Canberra, ACT, Australia.

***The Coastal GOOS plan will identify priority indicators of ecosystem states (health) to guide the requirements for coastal observing system capabilities: Surface phytoplankton biomass and subsurface oxygen fields; Waterborne pathogens and toxic phytoplankton; Living benthic habitats and ecological buffers to coastal flooding; Calcareous organisms; and, Exploitable fish stocks.***

GOOS-193: Requirements for Global Implementation of the Strategic Plan for Coastal GOOS (aka PICO)

***The IGOS Coastal Theme identified two priority issues to focus on: Coastal populations at risk, including coastal hazards and coastal development and urbanization and; Coastal ecosystems, including the hydrological and biogeochemical cycles, and ecosystem health and productivity. The goal of the Coastal Theme is to develop a strategy for integrated observations across the land-sea interface…***

Integrated Global Observing System (IGOS): A COASTAL THEME FOR THE IGOS PARTNERSHIP, Report of the Coastal Theme Team, January 2006