ADAPTA BLUES

"Adaptation to climate change through management and restoration of European estuarine ecosystems".

D A3.1: Protocol for the mapping of inland migration areas for estuarine habitats

Deliverable ID	**D1.1**
Due Date of Deliverable	**31/07/2020**
Submission Date	**31/07/2020**
Dissemination level[1]	**PU**
Lead partner	**FIHAC**
Contributors	
Grant Agreement No.	**LIFE18 CCA/ES/001160**

With the contribution of the LIFE Programme of the European Union

[1]PU = Public; CO = Confidential, only for members of the consortium (including the Commission Services); CL = Classified, as referred to in Commission Decision 2001/844/EC

Prepared by	Reviewed by	Approved by

Issue	Date	Description	Authors
1.0	31/07/2020	Protocol for the mapping of inland migration areas for estuarine habitats	

TABLE OF CONTENTS

1 INTRODUCTION

The main goal of this report is to define a protocol to identify potential areas for inland migration of estuarine habitats following sea level rise.

Sea level rise is expected to modify coastal wetlands and negatively affect some of the goods and services supported by these habitats (Craft et al., 2009; Yoskowitz et al, 2017). Inland migration is one of the mechanisms, along with sediment accretion, that allows coastal wetlands to adapt to sea level rise. In order to maximize the adaptative capacity of coastal wetlands, it is necessary to identify, manage and protect the lands that could facilitate the landward migration of wetlands trying to protect them against sea level rise effects (Wigand et al., 2017; Rogers et al., 2014).

In this protocol we propose a methodology to classify estuarine adjacent areas according to the potential to be colonized by estuarine communities considering the degree of human alteration, topographic and sediment characteristics.

2 ESTUARINE HABITATS MIGRATION

A key premise of sea level driven marsh expansion is the potential of marshes to migrate into adjacent uplands (Kirwan, 2016). In a purely natural setting, the future distribution of these migrating plants will be just predetermined by the accretion deficit and its interaction with the preexisting slope (Cahoon et al., 1995). However, in a transformed setting, like the current one, human development limits the potential migration of saltmarshes (Feagin et al., 2005; Desantis et al., 2007). Seawalls, dikes, roads and housing developments are defined as barriers to saltmarshes migration (Feagin et al, 2010; Smith, 2013).

According to Feagin et al. (2010), the zonal migration of the estuarine vegetation primarily depends on the relative sea level rise (SLR) rate, the vertical accretion rate and the availability of land at a suitable base elevation. Saltmarshes have been largely resilient to changes in SLR because marsh sediments generally accrete at rates similar or exceeding this historical SLR (Kirwan, 2016). Yet, human activities in estuarine areas (e.g. drainage, tidal restriction, dam building) constraint the capacity of saltmarshes to path with sea-level rise through vertical accretion, particularly in the current context of accelerated SLR in some regions (Craft et al., 2009; Kirwan and Megonial, 2013). When this occurs, marsh have to migrate onto uplands to be sustained (Feagin et al., 2010; Kirwan et al., 2016, Kirwan and Megonial, 2013).

3 HOW TO MAP INLAND MIGRATION AREAS

There are several spatially explicit models (i.e. MARGOT, The Marshes Governed by Tides; SLAMM, Sea Level Affecting Marshes Model) to forecast the long-term scenarios of habitats migration due to SLR. Nevertheless, the complexity of these models, the required data (e.g.

hydrology, sediment transport, erosion rates, etc) and calibrations complicate their use. In order to widespread the use of a common methodology to map the potential inland area for the migration of estuarine habitats, we propose a very simple and low-cost method based on geographical information.

The first step is defining the landward area adjacent to the estuarine surface within an elevation of 6 meters above mean sea level. With this elevation, we will identify both low-elevation lands, to allow marsh migration at low SLR, and higher-elevation land, which will be ineffective at low SLR but can enable migration at high SLR (Vinent et al., 2019).

Figure 1. Landward area within an elevation of 6 meters above mean sea level in the Bay of Santander (Cantabria).

In addition to meet the elevation criteria, potential migration land must be hydrological connected to saltwater (Clough et al., 2016). Therefore, the next step is identifying which of those areas show a natural connection to the estuary in order to guarantee the flooding of saltwater.

Within this framework, the land areas with hydrological connection to saltwater are those, adjacent to the estuary, with natural boundaries between aquatic and land environments. Therefore, all the areas limited by an anthropogenic structures (dikes, embankments, reinforced bank, etc) will be defined as non-potential areas for saltmarshes migration.

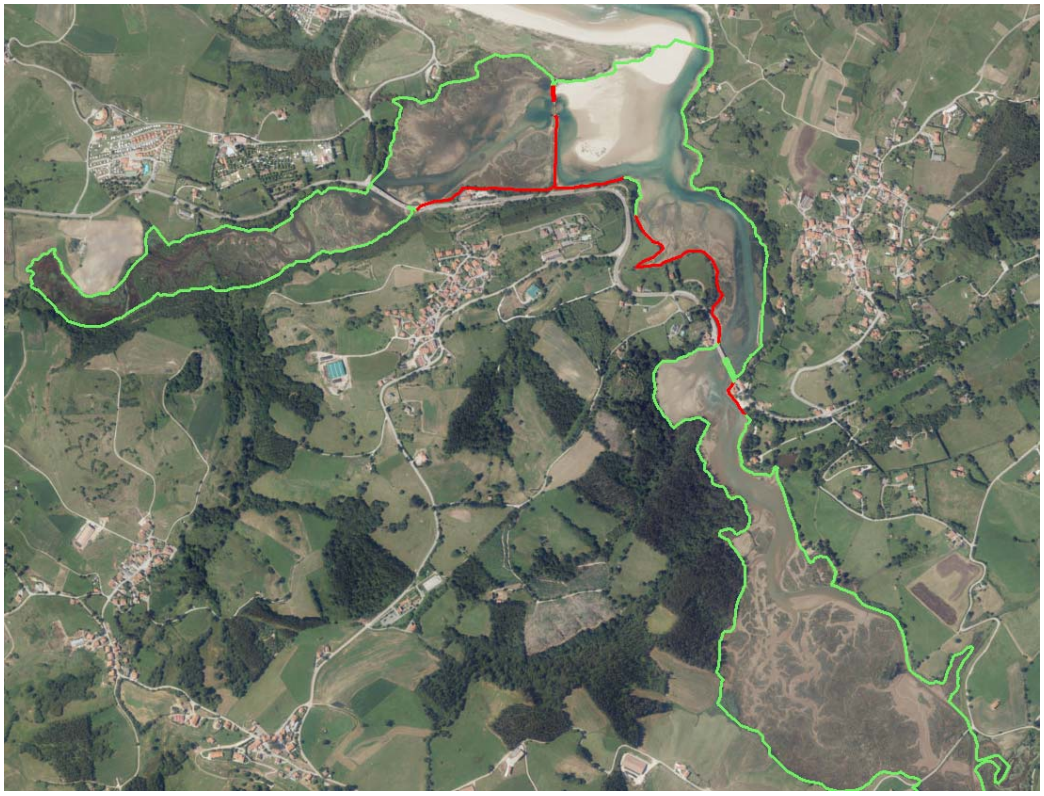

Figure 2. Natural boundary (green line) and anthopogenic boundaries (red line) between aquatic and land estuarine environments in Oyambre (Cantabria).

Figure 3. Examples of anthropic boundaries between aquatic and land environments in an estuarine area.

In addition, the current land use of adjacent estuarine areas is critical for the potential migration of saltmarshes. According to different reports (The Nature Conservancy, 2011; The Nature Conservancy in Virginia, 2011; Bruce and Crichton, 2014), the suitable land uses for marsh migration are agricultural land, forests and intertidal areas.

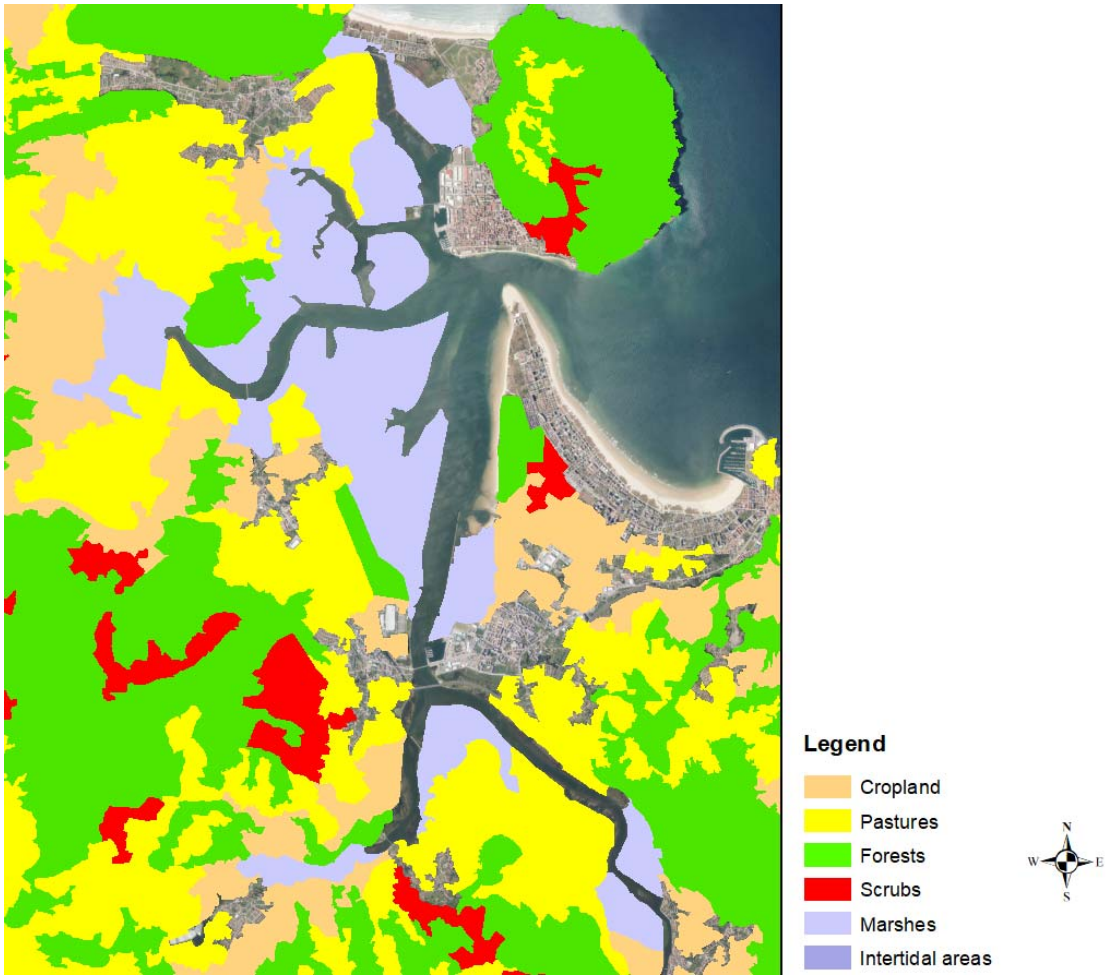

Figure 4. Land-uses close to the estuary area of Santoña marshes (Corine Land Cover, 2018).

Thus, the potential area for the migration of estuarine habitats has been defined as: the landward area close to the estuarine limits, located within the first 6 meters above sea level (altitude), with a natural connection to the estuarine area (not limited by anthropogenic structures such as levees or embankments) and nowadays occupied by agricultural land, forests or intertidal areas.

Figure 5. Areas within the first 6 meters above the mean sea level, without anthropic barriers to saltwater, and covered with agricultural, forestall and intertidal habitats.

4 REFERENCES

Bruce, C., Crichton, G. 2014. A revised assessment of protection priorities for the southern tip ecological partnership. In: STEP Meeting Presentation, February 20. The Nature Conservancy.

Cahoon, D. R., D. J. Reed, and J. W. Day, Jr. 1995. Estimating shallow subsidence in microtidal salt marshes of the southeastern United States: Kaye and Barghoorn revisited. Marine Geology 128:1-9.

Craft, C., Clough, J., Ehman, J., Joye, S., Park, R., Pennings, S., Guo, H., Machmuller, M., 2009. Forecasting the effects of accelerated sea-level rise on tidal marsh

ecosystem services. The ecological society of America. Frontiers in Ecology and the Environment 7 (2), 73–78.

Desantis, L. R. G., S. Bhotika, K. Williams, and F. E. Putz. 2007. Sea-level rise and drought interactions accelerate forest decline on the Gulf Coast of Florida, USA. Global Change Biology 13:2349-2360.

Feagin, R.A., Martinez, M.L., Mendoza-González, G., Costanza, R. 2010. Salt marsh zonal migration and ecosystem service change in response to global sea level rise: a case study from an urban region. Ecology and Society 15 (4): 14

Feagin, R. A., D. J. Sherman, and W. E. Grant. 2005. Coastal erosion, global sea-level rise, and the loss of sand dune plant habitats. Frontiers in Ecology and the Environment 3:359-364.

Kirwan, M.L. and Megonigal, J.P. Tidal wetland stability in the face of human impacts and sea level rise. 2013. Nature, 504: 53-60.

Kirwan, M.L., Walters, D.C., Reay, W.G., Carr, J.A. 2016. Sea level driven marsh expansion in a coupled model of marsh erosion and migration. Geophysical Research Letters, 43 (9): 4366-4373.

Rogers, K., Boon, P. I., Branigan, S., Duke, N. C., Field, C. D., Fitzsimons, J. A., Saintilan, N. 2016. The state of legislation and policy protecting Australia's mangrove and salt marsh and their ecosystem services. Marine Policy, 72, 139–155.

Smith, J. A. (2013), The role of Phragmites australis in mediating inland salt marsh migration in a Mid-Atlantic estuary, PLoS One, 8 (5): e65091.

The Nature Conservancy, 2011. Effects of global climate change at the Virginia Coast Reserve. Report from the Virginia Coast Reserve Climate Change Threats Workshop.

TheNature Conservancy inVirginia, 2011. The EasternShore ofVirginia: strategies for adapting to climate change. Report from the Eastern Shore Climate Change Adaptation Strategies Workshop.

Vinent, O.D., Johnston, R.J., Kirwan, M.L., Leorux, A.D., Martin, V.L. 2019. Coastal dynamics and adaptation to uncertain sea level rise: Optimal portfolios for salt marsh migration. Journal of Environmental Economics and Management, 98

Wigand, C., Ardito, T., Chaffee, C., Ferguson, W., Paton, S., Raposa, K., Watson, E. 2017. A climate change adaptation strategy for management of coastal marsh systems. Estuaries and Coasts, 40, 682–693.

Yoskowitz, D., Carollo, C., Pollack, J. B., Santos, C., & Welder, K. 2017. Integrated ecosystem services assessment: Valuation of changes due to sea level rise in Galveston Bay, Texas, USA. Integrated Environmental Assessment and Management, 13, 431–443.