Summary Results for WP8 "Cross-scale interactions"
31 January 2018

Task 8.1/D8.1 "Downscaling": The newly developed techniques to improve the representation of the fine-scale daily precipitation in complex and spatially heterogeneous regions such as mountain areas has proven to reconstruct small-scale precipitation distribution in the Alps. The techniques has been employed for a number of applications, including the analysis of extreme events and their statistics, and hydro-meteorological hazards. (Terzago et al. Submitted.)
After having elaborated a common protocol for ecosystem modelling within PAs, this newly developed technique has been used to produce downscaled precipitation for 14 ecological modelling applications. Within the flow of ECOPOTENTIAL, these data provide the basis to estimate climate change impacts to the PAs (see section "future simulations" below with some first results). The development of the downscaling techniques and the application of it to the different PAs led to D8.1 "High resolution (1-10 km) climate, land use and ocean change scenarios" (Submitted in M30).

Task 8.2 "**Upscaling":** Ground meteorological data and MODIS-derived NDVI and LST have been used to test the distribution of climatic growth limiting factors over Europe based on the hypothesis that vegetation growth in the South is governed by water and in the North by energy limitation. First results for single months confirm significant negative correlation between LST and NDVI for the South (water limitation) and positive correlation for the North over long-term average LST and NDVI (energy limitation). Seasonal shifts and the transition zones are further foci of the investigations.

Task 8.3/D8.3 "Uncertainty and Data Assimilation": Results from uncertainty analyses addressed mainly the effect of model selection.

(1) Results on uncertainty by model selection show how crucial the choice of models is. In this case, it shows how sensitive the results are on the future of the chamoix population in the Gran Paradiso National Park. For unstructured population models the population seems stable under climate change conditions, but not for structured models fitted for the same data.
(2) The effects of autocorrelation on the efficacy of model selection techniques has been theoretically investigated, specifically information criteria and cross-validation. To underpin these finding, a numerical study has been designed which provides empirical evidence. The empirical study showed that reindeer tend to respond positively to cold winters, possible due to decreased thawing and freezing of water. (Wheatcroft and Smith. In prep.)
(3) The probability has been tested that the best model occurred by chance when applying a model selection procedure. For the models on reindeer population, this probability is reasonably high ($p=0.16$) when all the data are considered, but very low ($p<0.01$) when an unusually cold winter is left out. The methodology has also been applied to models of ibex populations for which the probability of finding such good models by chance was extremely low. (Wheatcroft and Smith. In prep.)

Task 8.4/D8.2 "Current state of ES and ESS": Diverse, large-scale assessments have been conducted, which complement the work in single PAs and storylines and indicate important aspects for systematic evaluation of a European-wide network of PAs to stabilise and conserve biodiversity. Study (1), (2) and (3) investigate the existing network of European PAs and identify key aspects to underpin the need and important criteria for a continent-wide PA strategy. Study (4) investigates critical consequences of mainstreaming ecosystem services also for conservation in designated PAs. Study (5) and (6) show exemplarily the smart applications of large-scale data, both species monitoring and Remote Sensing data, to address critical questions of habitat suitability and ecosystem vulnerability.

(1) Based on a number of conservation values (e.g. reported species, area-controlled surplus of reported species, rarity-weighted richness, average rarity, total dissimilarity...) a

European wide assessment of PAs shows the sensitivity of scorings through different indicators and suggests systematic evaluation to guide a pan-European conservation strategy. (Hoffmann et al. Submitted.)

(2) Among the many factors influencing habitat richness, the area of PAs, latitude and topographic complexity are key factors to design effective continental-scale conservation of biodiversity. This finding calls for a strategic continental-scale design of European network of PAs (Mwaanga, B. 2017.Master Thesis.)

(3) Based on oceanic reanalyses incorporating RS measurements as drivers for lagrangian biophysical modelling of *Posidonia oceanica*, we evaluated spatiotemporal patterns of potential connectivity at the scale of the whole LME, over a climatically relevant temporal frame (1987-2015). Simulations reveal that time-persistent, short-range, along-coasts connections coexist with some notable long-range dispersal events that are less constant in time, yet geographically structured (with a key role played by cross-continental connections in the Alboran sea, the Sea of Sicily and the Libyan sea). Indicators derived from complex network theory are used to identify hotspots of connectivity that could inform marine protection planning in either European or North African coasts, or both. (Mari et al. In prep.)

(4) An integrated toolbox has been developed. This toolbox identifies, for instance, sites with suitable conditions for fish growth over the entire Mediterranean Sea, based on satellite-derived water quality information such as Sea Surface Temperature and Chlorophyll-a concentration. It is to be further developed to an EO downstreaming service, that collects the workflows of processing procedures to support the planning of maritime uses. (Valentini et al. 2016.)

(5) From a vulnerability assessment over 18,783 European freshwater catchments and 1,685 species, Lakes Ohrid and Prespa as well as freshwater ecosystems on Mediterranean islands were identified most vulnerable to climate change. Furthermore, only <25 % of the 573 freshwater ecosystems, identified as highly vulnerable in this study, are currently part of the European protected area network. This vulnerability assessment indicates solidly priorities for enhancing the connectivity and the protection of freshwater habitats. (Markovic et al. 2017.)

Task 8.4/D8.4 "Future simulations of ES and ESS": Model-based climate change impact studies in at least four different PAs have been/will be conducted based on the stochastically downscaled climate data (see Task 8.1). Results include:

(1) Mean water deficit will increase for semi-permanent wetlands in the Mediterranean from 2050 (-1489 mm) to 2100 (-1565 mm), with large discrepancies among countries, based on a climate change impact assessment of the hydrological functioning for 263 wetland spread over 23 countries around the Mediterranean Sea. (Lefebvre et al., abstract submitted, paper to come.)

(2) Uncertainties for different marine species and the foodweb are being quantified in a model experiment for the Wadden Sea. (Ziemba et al., first results, paper to come)

(3) Despite a number of uncertainties, a strong climate change impact is expected in the vegetation composition of the semi-arid transition zone in the northern Negev, with a heavy decline in shrubs and perennials, and a reduction in overall vegetation cover and biomass. (Steinmar et al. In prep.)

(4) A metapopulation ecology modelling framework has been developed to study species extinction dynamics in response to climatic change simulated by rising temperatures. The model estimates patch occupancy and can predict future changes in metapopulation capacity and species extinction dynamics. Geomorphic and altitude attributes as surrogates of habitat suitability at a regional scale foster predictable extinction dynamics induced by climatic change (Giezendanner et al., to be submitted to PNAS). The model is now being calibrated on presence/absence data of carabids species recorded at the GPNP.

List of published and submitted publications

- Terzago, S., Palazzi, E., and von Hardenberg, J. Stochastic downscaling of precipitation in complex orography: a simple method to reproduce a realistic fine-

scale climatology, Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2017-452, in review, 2018.

- Imperio, S., Corlatti, L., Bassano, B. & A. Provenzale. Submitted. Population dynamics of a mountain ungulate between past and future uncertainties. Global Change Biology.
- Hoffmann,S., Beierkuhnlein, C., Field, R., Provenzale, A., & A. Chiarucci. Submitted. Uniqueness of Protected Areas for Conservation Strategies in the European Union. Scientific Reports.
- Markovic, D., Carrizo, S.F., Archer, O.K., Walz, A. and David, J.N.W. 2017. Vulnerability of European freshwater catchments to climate change. Global Change Biology 23(9): 3567–3580. 10.1111/gcb.13657
- Valentini, E., Filipponi, F., Nguyen, X., Passarelli, A., Francesco, M., & A. Taramelli. 2016. Earth Observation for Maritime Spatial Planning: Measuring, Observing and Modeling Marine Environment to Assess Potential Aquaculture Sites. Sustainability, 8(6), 519
- Giezendanner, J., Bertuzzo, E., Pasetto, D., Guisan, A., Rinaldo, A. Geomorphic effects on metapopulation range dynamics and extinctions under climate change. To be submitted to PNAS.
- Caras, T., Hedley, J. and Karnieli 2017. Implications of sensor design for coral reef detection: Upscaling ground hyperspectral imagery in spatial and spectral scales International Journal of Applied Earth Observation and Geoinformation. 63, 68-77. dx.doi.org/10.1016/j.jag.2017.07.009
- Paz-Kagan, T., Caras, T., Herrmann, I., Shachak, M. and Karnieli, A. 2017. Multiscale mapping of species diversity under changed land-use using imaging spectroscopy. Ecological Applications, 27, 1466-1484. DOI10.1002/eap.1540.
- Oriani, F., Ohana-Levi, N., Marra, F., Straubhaar, J., Mariethoz, G., Renard, P., Karnieli, A. and Morin, E. 2017. Simulating small-scale rainfall fields conditioned by weather state and elevation: A data-driven approach based on rainfall radar images. Water Resources Research, 53, 1-21. DOI: 10.1002/2017WR020876

Abstracts submitted and published

- Lefebvre, G., Redmond, L., Germain, Ch., Palazzi, E., Terzago, S., Poulin, B., and Grillas, P. Submitted. Foreseen impacts of climate changes on wetland hydrology in the Mediterranean area. Wetland Scientist Meeting, June 2018, Denver, Colorado.
- Valentini, E., Filipponi, F., Nguyen, X., Passarelli, A., Francesco, M., & A. Taramelli. 2016. Marine food provision ecosystem services assessment using EO products. European Space Agency Living Planet Symposium. Prague, Czech Republic from 9-13 May 2016.

List of planned publications

- Steinmar, K., Tietjen, B., Schulz, J., Fiedler, S., Karnieli, A. & A. Walz. In prep. Shift in vegetation composition in semi-arid transition zones with climate change in the northern Negev, Israel. To be submitted to Ecological Modelling.
- Bargmann, T., Wheatcroft, E., Imperio, S., Vetaas, O. In prep. Modelling the wild reindeer population in Hardangervidda (provisional). Journal to be decided.
- Wheatcroft, E., Smith, L.A. In prep. Multiple significance testing of correlated models (provisional). Journal to be decided.
- Mari, L., Melia', P., Fraschetti, S., Gatto, M. & R. Casagrandi. In prep. Recent trends of changing connectivity for the seagrass Posidonia oceanica in the mediterranean sea. To be submitted to Global Change Biology.
- Karnieli, A., Beierkuhnlein, C., Provenzale, A. & Walz, A. In prep. Satellite-derived spatial and temporal distribution of vegetation grouth limited factors over Europe. Journal to be decided.

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