Technical progress report-July 2018

Name of Case Study
Climate Change impacts on the biodiversity of tropical ecosystems

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How do you plan to use the CDS toolbox to produce and visualize CIIs?
We will use selected CMIP5 ensemble bias-corrected to HydroGFD projections at 50 km grid scale from the contract's data to produce moderate and high emission scenarios for mean and maximum daily, monthly and annual precipitation and temperature for 2030 and 2050 at a $1km^2$ grid over Costa Rica. This last step (5) in our workflow started 9th July and we are currently producing the continuous daily climate reference grids for downscaling and bias-correction based on a dynamic multiple linear regression analysis for interpolation. We would use the CDS toolbox for retrieving daily gridded data within a specific time period and apply functionalities as masking and resampling to prepare the data for further analysis.

Preliminary results following the workflow
Below, we stepwise discuss the progress of the initially proposed workflow (Fig. 1). However, we only present figures that were not yet included in the web presence:

Figure 1: Proposed workflow of the project "Climate Change impacts on the biodiversity of tropical ecosystems" developed by the University of Costa Rica together with GIZ and SINAC.

Step 1: Produce precipitation and temperature climatologies purely based on local station data (annual and monthly).

Done and annual averages online (climate atlas).

Here, we show the mean monthly climatologies of precipitation (Fig. 2) and temperature (Fig. 3). The interpolated grids will be made publicly available. Precipitation was interpolated with a "spline with tension" algorithm using 192 station observations with at least 10 years of continuous data in between the period from 1960 to 2000. The 12 temperature maps were created based on individual temperature – elevation linear regressions models ranging from R^2 = 0.82 in February to an R^2 = 0.96 in September. These regression models were then used for spatial interpolation with a 30m digital elevation model:

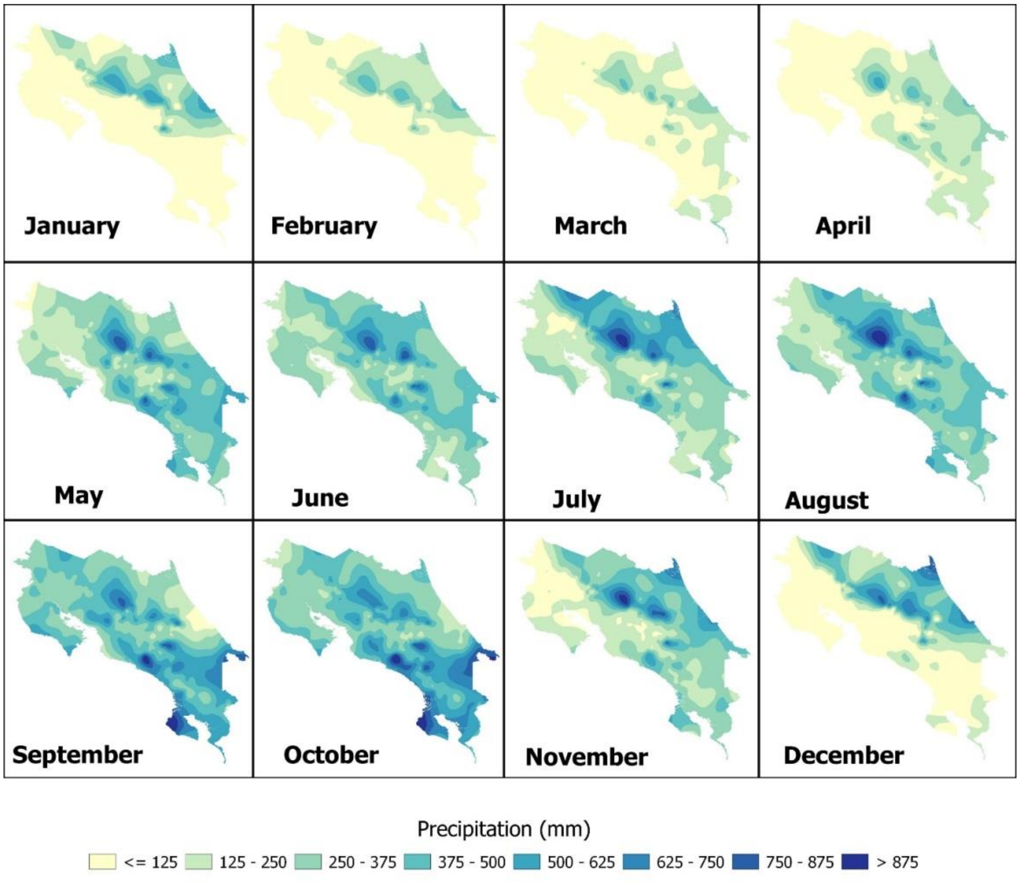

Figure 2: Mean monthly interpolated precipitation maps for Costa Rica. Each map shows eight intervals equal to 125mm per month.

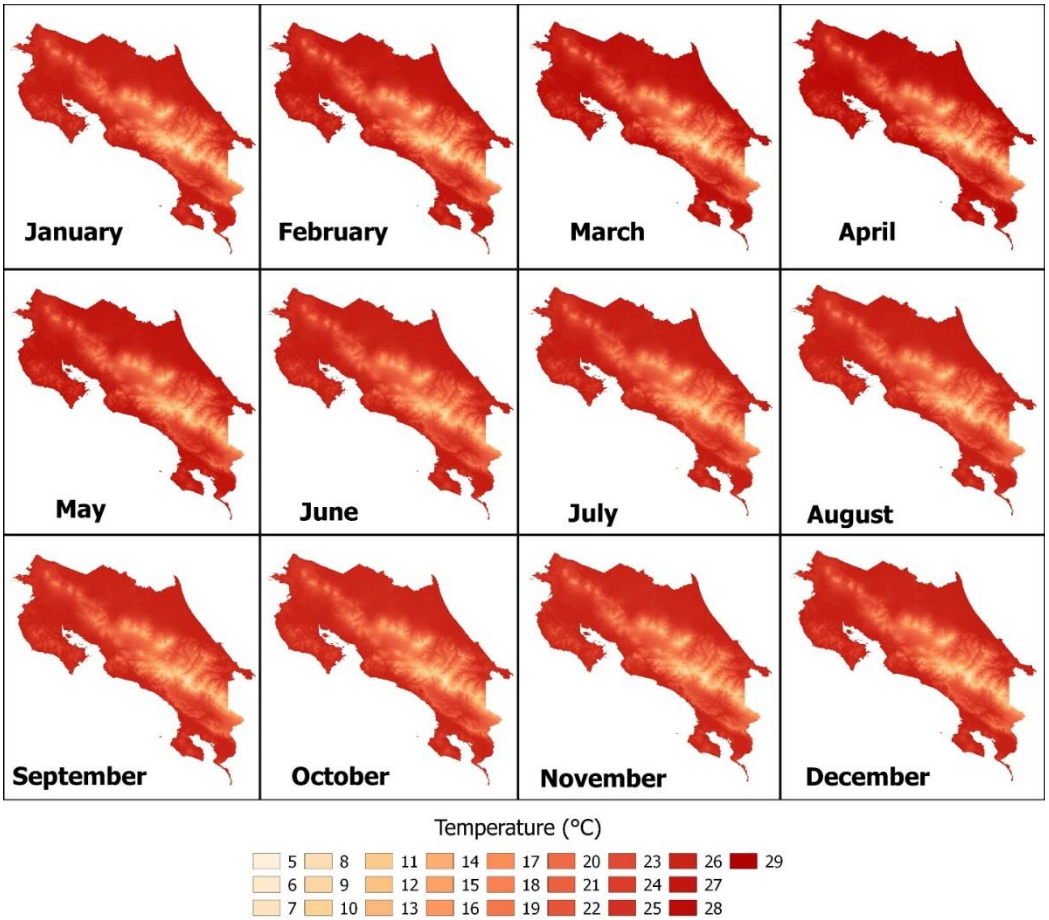

Figure 3: Mean monthly interpolated temperature maps for Costa Rica. Temperature ranges from 4°C to 30°C with classes of 3°C.

Step 2: Calculate land use-based biodiversity indicators for the national biocorridor program of our partners.

Done and online (climate atlas), R code was already provided for D5.2.1A.

Step 3: Calculate updated national Holdridge life zone biodiversity indicators with potential link to species distribution based on the local climatologies generated under step 1. Calculate remote sensing based Net Primary Productivity (NPP) anomalies.

Done and online (climate atlas).

Step 4: Merge land use-based biodiversity indicators and NPP anomalies on a national scale with updated Holdridge life zones.

Done and partly online (climate atlas).

Here, we show the merged biodiversity indicators that we aim to project into the future using the results from the currently ongoing work under Step 5, which are currently not yet online. The "potential" life zones (from Step 3) were converted into "actual" life zones using the most recent land cover product (2012) available from our partners. The natural land covers (forests, grasslands and paramo) were used to extract the life zones with the highest probability of existence (Figure 4). The blank space in the map of Figure 4 shows land use conversions (e.g. forest into pasture and/or agriculture) that do not correspond to the life zone ecosystems anymore. The actual life zones will be projected into the future with projected annual precipitation and temperature trends from Step 5.

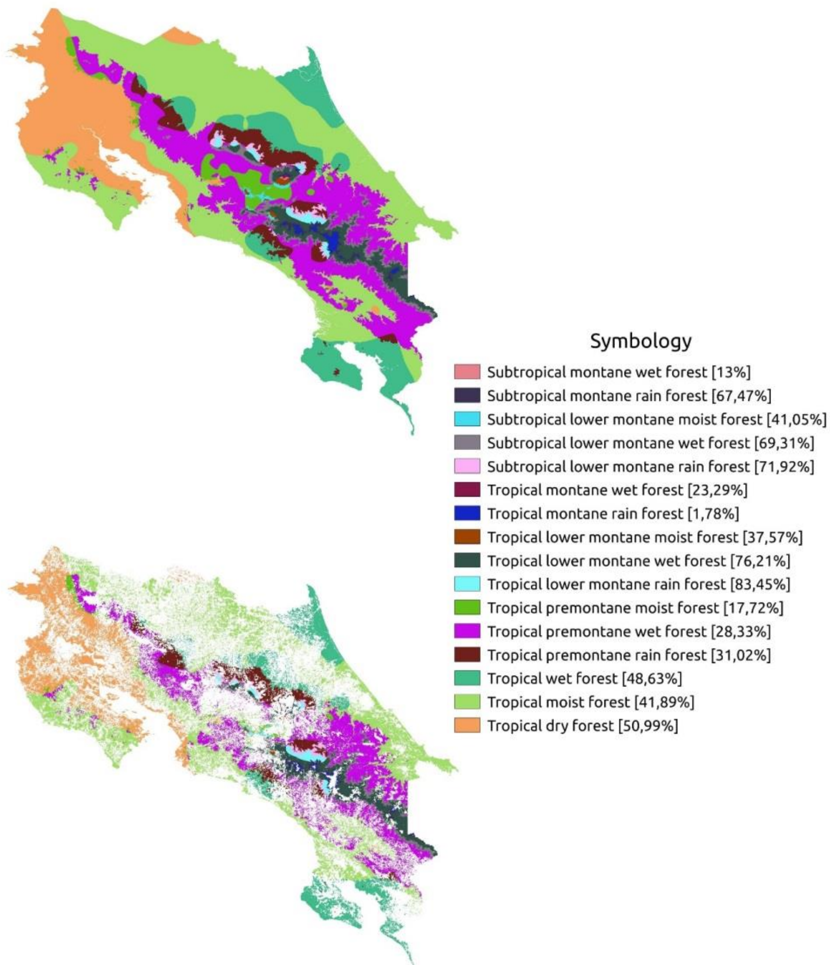

Figure 4: Potential and actual life zones displayed as percentages in the symbology across Costa Rica.

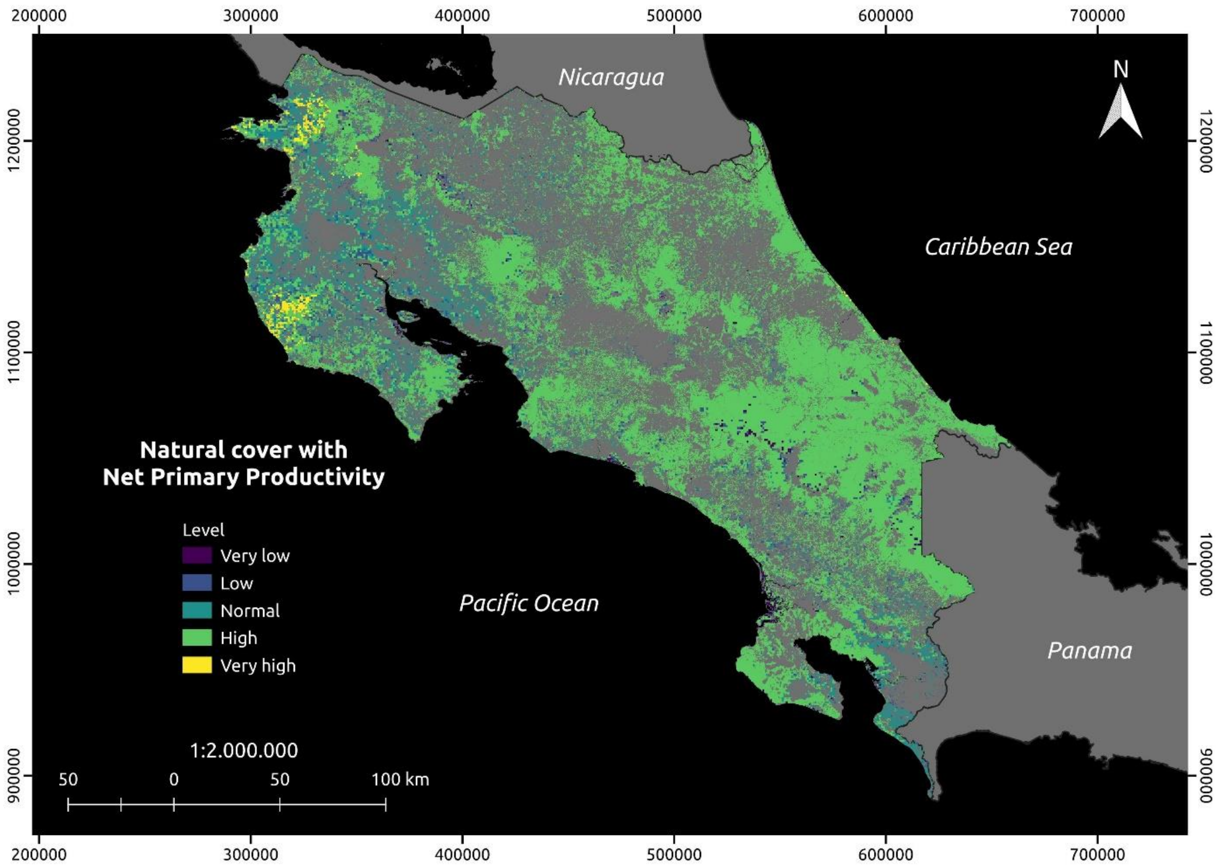

Figure 5: The actual life zone map from Figure 4 merged with long-term NPP estimates reclassified to visualize from low to high productivity.

Step 5: Downscale and bias-correct global climate data for Costa Rica (CMIP5 ensemble bias-corrected to HydroGFD at 50 km grid scale) to national data product created in Step 1. Project the merged biodiversity indicator(s) into climate change impact period.

Currently ongoing:

- We are in the process of producing the continuous daily climate reference grids for bias-correction of the GCM ensemble based on a dynamic multiple linear regression analysis for interpolation of station observations.
- The next step will be to use quantile mapping for bias correction (Pierce et al., 2015)
- The daily moderate and high emission scenarios will be aggregated to monthly and annual projections.

- The projections will be used to re-calculate the actual life zones from Figure 4 and 5 as a basis to identify "climate sensitive regions".
- The latter main product will be communicated to our partners to discuss potential implementation into adaptation efforts of the ongoing bio-corridor project at the National Park authority.

Pierce, D., D. Cayan; E. Maurer; J. Abatzoglou, K. Hegewisch, 2015, Improved bias correction techniques for hydrological simulations of climate change, J. Hydrometeorology 16, 2421–2442, doi: http://dx.doi.org/10.1175/JHM-D-14-0236.1.

What is the key messages, trends for local/regional CIIs?

Analysis of observed data by Hidalgo et al. (2017) and regional climate model analysis by Amador et al. (2018) suggest that there is a statistically significant temperature increase over Costa Rica. However, precipitation patterns are variable and mostly statistically insignificant. Trends are projected towards drier conditions in the north and wetter conditions in the south and a repeating pattern of a drier Pacific and wetter Caribbean slope.

We hope to be able to reproduce these patterns with our own analysis and due to an increase in spatial scale maybe even improve on the current state of the art. However, we first need to complete the work on Step 5 to be able to claim key messages and trends.

Amador, J.A., T. Ambrizzi, R.W. Arritt, C.L. Castro, T. Cavazos, R. Cerezo-Mota, R. Fuentes-Franco, F. Giorgi, G. Guiliani, H. Lee, M. Méndez-Pérez and E.R. Rivera, 2018. Putting into action the REGCM4.6 regional climate model for the study of climate change, variability and modeling over Central America and Mexico. Atmósfera, 31(2), 185-188. doi: 10.20937/ATM.2018.31.02.06

Hidalgo, H., Alfaro, E. & Quesada-Montano, B. (2017). Observed (1970–1999) climate variability in Central America using a high-resolution meteorological dataset with implication to climate change studies. Climatic Change. 141, 13-28. doi:10.1007/s10584-016-1786-y

What is your preliminary analysis on importance for decision making?

Our preliminary analysis on the importance for decision making mainly based on three meetings with our partners clearly showed the need for climate impact indicators tailored towards the specific needs such as for the future adaptation measures of bio corridors. Such information needs to be openly accessible and in a user-friendly format, which is something we target after discussions of our products.

However, it also must be clearly said that the final impact and implementation of our data and products will be out of our competence and fully dependent on the political arm of the partnering institutions. We anticipate that with the web presence and some promotion using our own network that it will be possible to reach a wider audience beyond our current focus on working with the established partners/clients. Such promotion and outreach activities will likely increase the longer-term impact of this project in Costa Rica.

What are the potential adaptation measures based on your interactions with clients?

Cost-benefit analysis of climate adaptation is just starting in Costa Rica as part of the GIZ supporting role to the National Park authority SINAC. This project and the data it will generate can help in this regard, but it will need longer term and continuous assessments of the changes potentially being introduced by implemented adaptation strategies. This type of monitoring over time will show the effectiveness of adaptation or leads to a modification of the initial strategy. We collaboratively identified the key adaption measure will be to target conservation and protection measures (PES) to "climate sensitive areas within and close to the proposed bio-corridors and national parks. The latter could potentially increase connectivity among protected areas and will be analyzed together as soon as the main products are completed.