climada module **flood** 8 June 2016

https://github.com/davidnbresch/climada_module_flood
david.bresch@gmail.com
gilles.stassen10@imperial.ac.uk
melanie.bieli@bluewin.ch

The CLIMADA module flood allows to generate flood hazard event sets and to conduct a probabilistic hazard risk analysis which quantifies the rate (or probability) of exceeding various flood heights at a specific geographic location. In particular, the flood module can be used to derive estimates of global country-specific expected flood damages over various return periods.
Consider the CLIMADA module country_risk[1] and/or GDP_entity[2] to generate the entities and centroids for the flood module.

This documentation is by far NOT complete yet (to say the least)

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[1] See https://github.com/davidnbresch/climada_module_country_risk and there climada_high_res_entity
[2] See https://github.com/davidnbresch/climada_module_GDP_entity

Flood: Hazard profile

Flooding is the most common environmental hazard worldwide. This is due to the vast geographical distribution of river floodplains and low-lying coastal areas. A flood is largely classified as 'an overflowing of water onto normally dry land' [1].
This encompasses the simple notion that a flood involves an excess of water compared with average water levels. Floods can be categorized as either river floods or coastal floods. River floods are often atmospherically driven, caused by excessive precipitation. They can also occur due to landslides falling into rivers, and by dam or levee failures. Coastal surges are often due to storm surges caused by tropical cyclones or tectonically produced tsunamis.
The primary effects of flooding include loss of life, damage to buildings and other structures, including bridges, sewerage systems, roadways, and canals. Floods also frequently damage power transmission and sometimes power generation, which then has knock-on effects caused by the loss of power. In the US, flooding has caused an average annual economic loss of US$ 8.2 bn and 89 fatalities over the last 30 years [2].

Overview of functions implemented

The CLIMADA module flood contains the following functions:

- `fl_centroids_prepare` prepares the centroids for the generation of a flood hazard event set by calling
  - `centroids_fl_score_calc` assigns flood scores and topographic wetness indices to a given centroids structure
  - `centroids_basinID_assign` assigns basin IDs to the centroids based on HydroSHEDS basin outline shapefiles[3]. At its core, the function calls `basin_identify`, which identifies the basins the centroids are located in.
  - `centroids_ET_assign` assigns mean annual evapotranspiration (ET) values to the centroids [mm/yr)]
  - `centroids_SWI_assign` assigns soil wetness indices (SWIs) to the centroids [%]
  - `centroids_WHC_assign` equips the centroids with values for available water-holding capacity (WHC) of the soil [mm]
- `climada_fl_hazard_set` generates a flood hazard set by distributing rainfall volume into the basins according to the centroids' wetness indices
- `fl_hazard_plot_hr` makes plots of specific flood events

further helper functions:

- `dem`
  `landcolor`
  `seacolor`
  These three functions allow to produce nicely colored plots of digital elevation data
- `fl_Climada_Aqueduct_compare` compares flood damages calculated by Climada to the flood damage estimates of the Aqueduct Global Flood Analyzer[4]. This function is only used as an intermediate step in the calibration of flood damages / hazard intensities and might be removed from the repository later. The "country flood risk" struct needed as input can e.g. be generated using the script `fl_countryrisk_generate`
- `structfind` finds the index of a certain string or value in a struct (used in

[3] HydroSHEDS is a set of hydro information mapping products at regional and global scales. For more information and a technical documentation see http://hydrosheds.org/page/hydrobasins, and to download the basin shapefiles see http://hydrosheds.cr.usgs.gov/dataavail.php

[4] The Aqueduct Global Flood Analyzer developed by the World Resources Institute (WRI) is a free web-based interactive platform which measures river flood impacts by urban damage, affected GDP, and affected population at the country, state, and river basin scale across the globe. For more information see http://www.wri.org/resources/maps/aqueduct-global-flood-analyzer

```
fl_Climada_Aqueduct_compare)
```

Flood hazard analysis: A step-by-step guide

Creating a probabilistic flood hazard set for a country of your choice (we will use Italy as an example) requires the following steps:

[to be added]

Flood data sources

There are plenty of open-access flood (and rain) data sources, worth mentioning a few:

- http://www.mmnt.net/db/0/0/ftp.cgd.ucar.edu/archive/PRECIP in there GPCP_1DD_v1.2_199610-201507.nc.gz. See climada code `DEM_rainfall`
- ftp://trmmopen.gsfc.nasa.gov/pub/trmmdata/GIS/README.GIS.pdf. See climada code `trmm_get`
- http://chg.geog.ucsb.edu/data/chirps/#_Data. See climada code `chirps_read`
- http://daac.ornl.gov/RIVDIS/rivdis.shtml. See climada code `RivDIS_read`
- http://hydrosheds.cr.usgs.gov/index.php
- http://edcdaac.usgs.gov/gtopo30/hydro, documented in http://pubs.usgs.gov/of/2007/1441/
- https://lta.cr.usgs.gov/HYDRO1K 1 km resolution DEM flood-corrected, see also access via https://ers.cr.usgs.gov

Bibliography

[1] "Natural Disasters Association," [Online]. Available: http://www.n-d-a.org/flooding.php. [Accessed 16 March 2015].

[2] Hydrologic Information Center, "National Oceanic and Atmospheric Administration (NOAA)," [Online]. Available: http://www.nws.noaa.gov/hic/. [Accessed 16 March 2015].

[1] Please note that the Climada module GDP_entity has to be installed for this step.
Download: https://github.com/davidnbresch/climada_module_GDP_entity