README

Version 1 – 19 June 2024

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This README file describes the scripts and datasets that are used to create a worldmap. This worldmap shows the trends in major forcing factors (compound flood risk, sediment retention and relative sea-level rise) for 47 of the world's major river deltas. This worldmap is shown as a figure in the following publication:

van de Vijsel, R.C., Scheffer, M. & Hoitink, A.J.F. (2024). Tipping points in river deltas. *Nature Reviews Earth & Environment.*

Whenever you use any of the contents of this dataset, please refer to this dataset as well as the associated publication.

Contents

1. Purpose of the dataset

This README file describes the contents of the Matlab script **ReviewPaper_Worldmap_v1.m** and the input data needed.

The script **ReviewPaper_Worldmap_v1.m** uses input data from 3 earlier studies to create a worldmap. In this map, for 47 major river deltas, trends are shown for the following three forcings:
1. Compound flood risk due to combined storm surge and river flood
2. Sediment retention
3. Relative sea-level rise

The worldmap shows these projected trends for 47 major river deltas around the world.

2. Contents of this dataset

After having downloaded this entire dataset and having unzipped the folders, the following list of folders and files should be present within one directory:

- **ReviewPaper_Worldmap_v1.m**
    - This is the main script (to be run in Matlab) used to analyze the three existing datasets (compound floods, sediment budgets, relative sea-level change) and produce the worldmap. For further explanations, see the remainder of this README file (steps 4.1 and 4.3), as well as the explanations in the Matlab script itself.
- **selected_deltas.txt**
    - This text file contains the names of 47 major river deltas. The Matlab script opens and reads this text file, to determine for which river it should do calculations.
- **Couasnon2020NHESS**
    - This is a folder where the dataset from Eilander (2019) will be stored. That dataset was used to calculate compound flood statistics by Couasnon et al. (2020, Natural Hazards and Earth System Sciences). So far, this folder is empty. The instructions below (step 3.1) explain how the dataset from Eilander (2019) should be downloaded and moved into this folder.
- **Nienhuis2023AREPS**
    - This is a folder where the datasets from Nienhuis et al. (2020, Nature) and Nienhuis et al. (2023, Annual Reviews of Earth and Planetary Sciences) will be stored. Those datasets quantify sediment budget changes and relative sea-level rise, for river deltas worldwide. So far, this folder is empty. The instructions below (steps 3.2 and 3.3) explain how these datasets should be downloaded and moved into this folder.
- **MannKendall**
    - This folder contains one Jupyter Notebook, named **MannKendall.ipynb**. That script calculates trend statistics for the compound flood analyses done in the Matlab script (**ReviewPaper_Worldmap_v1.m**). Halfway running this Matlab script, a dialog box will appear that prompts the user to run this Jupyter Notebook. The output of this Jupyter Notebook will then be stored in the folder **MannKendall**. See the instructions below (step 4.2) as well as the Jupyter Notebook itself for more details.
- **output**
    - This folder is empty so far. The output (figures and a .mat-output file) from the Matlab script (**ReviewPaper_Worldmap_v1.m**) will be stored here, including the final worldmap that is shown in the Review Paper.
- **cmocean**
    - This folder is empty so far. The custom Matlab function *cmocean*, which is used to get suitable colormaps for the figures, will be stored here. See the instructions (step 3.4) below for more information.

3. To do before running the Matlab script

The following steps are needed before the Matlab script **ReviewPaper_Worldmap_v1.m** can be run:

3.1 Dataset of compound flood risk

Firstly, a dataset needs to be downloaded that contains time series of daily river discharge and storm surge height, around the world. This dataset will be used to calculate the trend in compound flood risk, which is shown in the worldmap.

1. Download the NetCDF file **discharge_surge_reanalysis_v2.nc** from the following repository: *Eilander, D. (2019). Paired time series of daily discharge and storm surge [Data set]. Zenodo. https://doi.org/10.5281/zenodo.3552820*.
2. Move this file to the folder **Couasnon2020NHESS.**

3.2 Dataset of sediment retention

Secondly, a dataset needs to be downloaded that quantifies sediment budget changes for river deltas worldwide. This dataset will be used to calculate sediment retention, as shown in the worldmap.

1. Download the zipped folder **GlobalDeltaChange-3.0.zip** from the following repository: *Jaap Nienhuis. (2022). jhnienhuis/GlobalDeltaChange: GlobalDeltaData v3.0 (3.0). Zenodo. https://doi.org/10.5281/zenodo.7044707*.
2. Unzip this zipped folder (now named **GlobalDeltaChange-3.0**), and move it (in its entirety) to the folder **Nienhuis2023AREPS**.

3.3 Dataset of relative sea-level rise

Thirdly, a dataset needs to be downloaded that contains the projected rates of relative sea-level change around the world. This data is used to show relative sea-level change projections for the 47 major river deltas in the worldmap.

1. Download the zipped folder **GlobalDeltaSeaLevel-2.0.zip** from the following repository: *https://github.com/jhnienhuis/GlobalDeltaSeaLevel/releases/tag/v2.0*.
2. Unzip the zipped folder (now named **GlobalDeltaSeaLevel-2.0**), and move it (in its entirety) to the folder **Nienhuis2023AREPS**.

3.4 Custom colormap

Fourthly, the custom Matlab colormap *cmocean* needs to be downloaded. This function is used to choose the color palettes used in the worldmap.

1. Download the zipped folder **github_repo.zip** from the Matlab File Exchange page of the cmocean package: *https://www.mathworks.com/matlabcentral/fileexchange/57773-cmocean-perceptually-uniform-colormaps*.
2. Unzip this zipped folder , and move its contents (so not the overarching folder **github_repo**) to the folder **cmocean**.

4. Running the analyses and producing a worldmap

Now that all necessary datasets and the custom colormap have been downloaded, the Matlab script **ReviewPaper_Worldmap_v1.m** can be run. This is the actual script that uses the previously published datasets and compiles them into the worldmap:

4.1 Opening and running the script in Matlab

1. Open the script in Matlab and press "Run all sections" (green "play" button) or press F5 (on Windows devices).
2. The script will now run through all the steps by itself.
3. The Matlab script loads the names of the 47 major river deltas (which are shown in the worldmap) from the text file **selected_deltas.txt**.
4. Somewhere halfway the calculations, the script is paused. A dialog box will appear, with the following message:
   Run the Python script "MannKendall/MannKendall.ipynb". After that, press CONTINUE
5. Leave this dialog box untouched for now, leave Matlab open, and proceed to the step below.

4.2 Opening and running the script in Jupyter Notebook

1. This dialog box appears after the trends in compound flood risk have been calculated in the Matlab script. As a next step, the statistical significance of these trends needs to be tested. For this purpose, a Mann-Kendall trend analysis is done. This analysis is done using a Python function. Therefore, it has to be done separately from the Matlab script.
2. Now open a Jupyter Notebook (e.g., via Anaconda, see https://docs.anaconda.com/ae-notebooks/user-guide/basic-tasks/apps/jupyter/).
3. Open the following Jupyter Notebook **MannKendall.ipynb**, that can be found in the folder **MannKendall**.
4. Run this entire Jupyter Notebook. The output of this script (trends and their statistical significance) will be stored in the folder **MannKendall**.

4.3 Continuing with the script in Matlab

1. Now that the Mann-Kendall trend analysis is completed, go back to the Matlab script.
2. Click on the button *CONTINUE* within the dialog box that had appeared.
3. The Matlab script should now continue running from the point where it paused earlier. The script now uses the trend statistics (calculated in the Jupyter Notebook) and shows the statistical significance of the compound flood trends in the worldmap.
4. The Matlab script will continue running, to analyze the projected sediment retention and relative sea-level rise.
5. A number of figures is produced. All these figures are automatically stored in the folder **output**.
6. At the end of the script, all data will be stored as **ReviewPaper_Worldmap_v1_output.mat**.
7. The final version of the worldmap, which is used in the review paper, is named **worldmap_final.pdf**.