

Dear Editor of *Earth System Science Data*

We hereby submit the revised version of our manuscript entitled “Data for wetlandscapes and their changes around the world” in response to the interactive review process in the ESSD journal. The revised manuscript and response files have been prepared by the core group of authors, including Navid Ghajarnia, Georgia Destouni, Josefin Thorslund, and Zahra Kalantari, and finally reviewed and revised by all other co-authors listed in the manuscript.

We thank the editor and reviewers for their constructive comments and suggestions. The paper is revised based on the comments given by the reviewers as explained in the “*Response file and manuscript revised_Changes highlighted*” file, with changes highlighted in red. Detailed responses to each and all of the comments and questions of both reviewers are also provided in the same file. All co-authors agree with the submitted revised version of the manuscript.

On behalf of me and all the co-authors

Yours sincerely,

Navid Ghajarnia

Question by Anonymous Referee #1:

The manuscript is generally very important because it summarizes the state of wetlands worldwide. But, though it is not the intention of the manuscript, the question is: Could it help to manage wetlands at a regional scale?

Response:

Thanks for your feedback.

The main idea in this research is to support and encourage large-scale studies of geographical, hydrological, hydroclimate and land use conditions and changes over the whole wetlandscapes, at different sites around the world that enables cross-regional comparisons. The introduced sites in the wetlandscape change database (WetCID) are located in different regions, with seven sites in Northern Europe (sites 1-7), seven in the Amazon and Caribbean region (sites 20 and 23-27), four in North America (sites 10, 15, 18, and 19), three in the Middle East (sites 12, 13, and 16), two in the Mediterranean region (sites 11 and 14), two in Siberia (sites 8 and 9), and two more in other parts of the world (Northern Africa and East Asia). As such, regional change patterns and characteristics can be identified, specifically over regions with higher number of sites. It can also highlight regional knowledge gaps or data availability as critical obstacles towards proper management of wetlands which is a first step to fulfill such shortcomings (e.g. lack of open data sources identifies for sites 13, 16, and 17 in the MENA region reported in lines 192-193 or lack of information regarding observed changes at sites 2 and 5 in North Europe reported in lines 198-199). Moreover, given the fact that this is a work in progress and the database can be updated with small time investment as information from new sites become available, more comprehensive regional evaluations can be expected from future versions of the WetCID.

In order to address this comment and clarify about it in the manuscript for similar interested audiences and WetCID users, the following parts of the manuscript are revised while lines 54-55 and 347-349 already discuss around the above question in the submitted version.

After the paragraph in lines 195-202 and before Figure 2, the following sentences are added: “Furthermore, the wetlandscapes of WetCID are located in different regions of the world, with seven sites in Northern Europe (sites 1-7), seven in the Amazon and Caribbean region (sites 20 and 23-27), four in North America (sites 10, 15, 18, and 19), three in the Middle East (sites 12, 13, and 16), two in the Mediterranean region (sites 11 and 14), two in Siberia (sites 8 and 9), and two more in other parts of the world (Northern Africa and East Asia). As such, regional patterns and characteristics can be identified, and regional strategies developed, e.g., to enhance availability of data and information, and determine further research needed to bridge region-specific knowledge gaps and decide on relevant management plans for each region’s wetland ecosystems. Such regional characterizations and assessments can be initialized with the current version of WetCID and further updated as more data for already included and possible additional regional wetlandscapes become available in future database versions.”

Suggestions by Anonymous Referee #2:

I recommend the Authors to add to the manuscript the table with basic information of wetlandscapes showed in Figure 1. Uniform black dots used for showing the presented individual objects on the map suggest that these objects are of similar size. However, based on the data presented in “Survey summary doc A_General site information” show that presented wetlandscapes are in differ total area and percentage of wetlands. This information added in table into manuscript could provide this basic information for readers. In my opinion, key information is also altitude (mean in case of small objects and mean, maximum and minimum in case of large ones) and salinity. Moreover, small technical correction in “Survey summary doc A_General site information – site info” are recommended: unify of font and some detail information, eg. in some cases there is information “326102 number of people for watershed”, however in the others “940 hab. (2002)”, “Total population of 2.9 million people implies an average population density of _ 78 people per km²”. It would be better to unify the way of presentation the population data, lakes data etc.

Response:

Thanks for your feedback and suggestions.

Based on your suggestion, we have now added Table 1 in section 3.1 of the revised manuscript. This table presents some selected fields of the “summary table sheet” in the “Survey summary doc A”, including site names, country, classification (wetlandscape or individual wetlands), climate zone, wetland type, and area of wetlands relative to total wetlandscape (catchment) area. The total wetlandscape (catchment) area is not added in Table 1 as this information is embedded as a graph in Figure 2. Specific salinity levels are not included either, as such data have not been provided for the different sites, and the focus of the current version of the Wetlandscape Change Information Database (WetCID) is on land use and hydroclimatic changes, rather than on water quality. However, the wetland type for each site, which is given in Table 1, clarifies if there are mainly freshwater, brackish water, or saline water wetlands at each site. Various water quality data are definitely interesting to consider and include in further developments of the database. Moreover, altitude is also useful information to add in future developed versions of WetCID database, even though it has not been collected and prepared at this stage.

The fonts, size and general format cells of Survey summary doc A are revised based on your recommendations (see the attached file). Different information items regarding latitude, longitude, climate zones, temperature, evapotranspiration, runoff, precipitation, groundwater table, and population, are also harmonized as much as possible. However, please note that, although we have defined a general structure for different existing fields in the survey forms (to harmonize reported data), we tend to keep additional information provided by each site’s researchers, as this provides valuable local insights. Therefore, this may cause some minor inconsistencies in level of available data among different sites.

The added Table 1 and its associated explanation in the revised manuscript are as follows:

In the beginning of section 3.1, between lines 188-191: “Table 1 summarizes some general geographical, climate, and wetland type information provided by GWEN researchers in the survey information forms. Each site represents either an individual wetland or a wetlandscape (e.g., a catchment) including multiple wetlands. The country, main climate zone and wetland area relative to total wetlandscape (catchment) area are also given for each site in Table 1.”

1 **Table 1.** General geographic, climate, and wetland type information for the 27 investigated wetlandscapes in WetCID. The data and information are based on
 2 survey responses by researchers with active research (on various topics) at each wetlandscape site.

Site No.	Site name	Country	Classification	Climate zone	Wetland type	Area of wetlands relative to total catchment/wetlandscape area (%)
1	Tavvavouma	Sweden	Wetlandscape	Subarctic	Peat plateau/thermokarst lake complex	2.8
2	Forsmark	Sweden	Wetlandscape	Humid continental (cold summer)	Bogs, fens, marshes, (shallow lakes)	0.01
3	Vattholma	Sweden	Wetlandscape	Humid continental (cold summer)	Bog, Fen, Riparian	-
4	North Baltic WMD	Sweden	Wetlandscape	Humid continental (cold summer)	Multiple	100
5	Simpevarp	Sweden	Wetlandscape	Humid continental (cold summer)	Bogs, fens	0.01
6	South Baltic WMD	Sweden	Wetlandscape	Humid continental (cold summer)	Multiple	100
7	Upper Lough Erne	Ireland	Individual wetland	Cold (dry winter, cold summer)	Flood plain/shallow lakes	22
8	Selenga	Russia	Wetlandscape	Cold (dry winter, cold summer)	Marshes (Riverine, Palustrine)	0.13
9	Volga	Russia	Wetlandscape	Cold (dry winter, cold summer)	Marshes (Riverine, Palustrine)	1.0
10	Le Sueur	USA	Wetlandscape	Temperate	isolated, fluvial/riparian, lakes/ponds, marshes, forest/shrubs, constructed	100
11	Sacca Di Goro	Italy	Individual wetland	Cold-summer Mediterranean	Shallow saltwater coastal lagoon	4.2
12	Lake Urmia	Iran	Individual wetland	Continental	Lake	8.8
13	Anzali Mordab	Iran	Individual wetland	Caspian or Hyrcanian climate	Inland and Marine/Coastal wetland	4.0
14	Gialova Lagoon	Greece	Individual wetland	Hot-summer Mediterranean	Coastal wetland	13
15	Lower Mississippi River Delta Plain	USA	Wetlandscape	Humid Subtropical	Riverine, Marine, Estuarine, Lacustrine	3.5
16	Shadegan	Iran	Individual wetland	Warm desert	Palustrine, Estuarine, Marin	31
17	Zone Humide de Souss	Morocco	Individual wetland	Mediterranean semi-arid	marine and coastal	0.01
18	Geographically isolated wetlands	USA	Wetlandscape	Humid subtropical	Freshwater marshes and swamps	100
19	Everglades	USA	Individual wetland	Tropical to Subtropical	Freshwater wetland, coastal wetland	32
20	CGSM	Colombia	Individual wetland	Tropical	Estuarine	-
21	Mekong Delta	Vietnam	Wetlandscape	Tropical Monsoon	Marine	5.0
22	Panama Canal	Panama	Wetlandscape	Tropical/Central America	River Chagres, Lake	100
23	León-Atrato	Colombia	Wetlandscape	Tropical rainforest	Marshes and Swamps	17
24	Lagunas Plaza and Grande	Colombia	Wetlandscape	Extremely cold and very dry	Glacial Lake	4.4
25	Fúquene, Cucunubá y Palacio	Colombia	Individual wetland	Cold and very dry	Natural shallow lake	1.7
26	Paramo Sumapaz	Colombia	Wetlandscape	Tropical	High altitude wetland	46
27	Pantanal	Brazil	Wetlandscape	Tropical savanna with dry-winter	Periodically inundated savanna	27

3

Data for wetlandscapes and their changes around the world

Navid Ghajarnia¹, Georgia Destouni¹, Josefin Thorslund¹, Zahra Kalantari¹, Imenne Åhlén¹, Jesús A. Anaya-Acevedo², Juan F. Blanco-Libreros³, Sonia Borja¹, Sergey Chalov⁴, Aleksandra Chalova⁴, Kwok P. Chun⁵, Nicola Clerici⁶, Amanda Desormeaux⁷, Bethany B. Garfield⁸, Pierre Girard⁹, Olga Gorelits¹⁰, Amy Hansen¹¹, Fernando Jaramillo^{1&12}, Jerker Jarsjö¹, Adnane Labbaci¹³, John Livsey¹, Giorgos Maneas^{1&14}, Kathryn McCurley¹⁵, Sebastián Palomino-Ángel¹⁶, Jan Pietroni^{1&17}, René Price¹⁸, Victor H. Rivera-Monroy¹⁹, Jorge Salgado²⁰, A. Britta K. Sannel¹, Samaneh Seifollahi-Aghmiuni¹, Ylva Sjöberg²¹, Pavel Terskii²², Guillaume Vigouroux¹, Lucia Licero-Villanueva²³, and David Zamora²⁴

¹ Department of Physical Geography, Bolin Center for Climate Research, Stockholm University, SE-10691 Stockholm, Sweden.

² Facultad de Ingeniería, Universidad de Medellín, Carrera 87 30–65, 050026 Medellín, Colombia, S.A.

³ Instituto de Biología, Facultad de Ciencias Exactas y Naturales, Universidad de Antioquia, Calle 70 No. 52-21, Medellín, Colombia

⁴ Faculty of geography, Lomonosov Moscow State University, Moscow, Russian Federation; 119571, Moscow, Russia

⁵ Department of Geography, Hong Kong Baptist University

⁶ Department of Biology, Faculty of Natural Sciences and Mathematics, Universidad del Rosario, Bogotá D.C., Colombia

⁷ School of Natural Resources and Environment, University of Florida, Gainesville, FL, USA

⁸ Department of Geography and Anthropology, Louisiana State University, Baton Rouge, LA, 70803 USA

⁹ Centro de Pesquisa do Pantanal, Cuiabá, Mato Grosso, Brazil

¹⁰ Zubov State Oceanographic Institute, Moscow, Russian Federation

¹¹ Civil, Environmental and Architectural Engineering Department, University of Kansas, Lawrence, Kansas, USA

¹² Baltic Sea Centre

¹³ Department of Geology, Faculty of Science of Agadir, Ibn Zohr University, Agadir, Morocco

¹⁴ Navarino Environmental Observatory, 24 001 Messina, Greece

¹⁵ Department of Soil and Water Sciences, University of Florida, Gainesville, Florida, USA

¹⁶ Facultad de Ingeniería, Universidad de Medellín, Carrera 87 30–65, 050026 Medellín, Colombia, S.A.

¹⁷ WSP Sverige AB, Ullevigatan 19, Gothenburg, 411 40, Sweden

¹⁸ Department of Earth and Environment and Southeast Environmental Research Center, Florida International University, Miami, FL 33199, USA

¹⁹ Department of Oceanography and Coastal Sciences, College of the Coast and Environment, Louisiana State University, Baton Rouge, LA, 70803 USA

²⁰ Departamento de Ciencias Biológicas, Universidad de Los Andes, Bogotá Colombia; Universidad Católica de Colombia, Bogotá Colombia

²¹ Department of Geosciences and natural resource management, CENPERM - Centre for Permafrost, University of Copenhagen, Copenhagen, Denmark

²² Faculty of geography, Lomonosov Moscow State University, Moscow, Russian Federation; 119571, Moscow, Russia

²³ Master student in Landscape Ecology and Nature Conservation, University of Greifswald, Germany

²⁴ Civil and Agricultural Department, Universidad Nacional de Colombia – Bogotá, Colombia

45 **Abstract.** Geography and associated hydrological, hydroclimate and land use conditions and their changes determine
46 the states and dynamics of wetlands and their ecosystem services. The influences of these controls are not limited to
47 just the local scale of each individual wetland, but extend over larger landscape areas that integrate multiple wetlands
48 and their total hydrological catchment – the wetlandscape. However, the data and knowledge of conditions and
49 changes over entire wetlandscapes are still scarce, limiting the capacity to accurately understand and manage critical
50 wetland ecosystems and their services under global change. We present a new **Wetlandscape Change Information**
51 **Database (WetCID)**, consisting of geographic, hydrological, hydroclimate and land use information and data for 27
52 wetlandscapes around the world. This combines survey-based local information with geographic shapefiles and
53 gridded datasets of large-scale hydroclimate and land-use conditions and their changes over whole wetlandscapes.
54 Temporally, **WetCID** contains 30-year time series of data for mean monthly precipitation and temperature, and annual
55 land use conditions. The survey-based site information includes local knowledge on the wetlands, hydrology,
56 hydroclimate and land uses within each wetlandscape, and on the availability and accessibility of associated local data.
57 This novel database (available through PANGAEA <https://doi.pangaea.de/10.1594/PANGAEA.907398>; Ghajarnia et
58 al., 2019) can support site assessments, cross-regional comparisons, and scenario analyses of the roles and impacts of
59 land use, hydroclimatic and wetland conditions and changes on whole-wetlandscape functions and ecosystem services.
60

61 **1 Introduction**

62 Wetlands contribute more than 20% of the total value of global ecosystem services (Costanza et al., 2014), while
63 covering only a small percentage (4-9%) of global land surface (Morganti et al., 2019; Zedler and Kercher, 2005;
64 Mitsch and Gosselink, 2000). Wetlands are associated with a diverse range of functions such as water quality
65 remediation (e.g., Chalov et al., 2017; Quin et al., 2015), regulation of soil moisture and groundwater replenishment
66 (e.g., Ameli and Creed, 2019; Golden et al., 2017), flood control (e.g., Quin and Destouni, 2018; Acreman and Holden,
67 2013), and biodiversity conservation (e.g., Cohen et al., 2016; Mitchell et al., 2008). Through these functions, wetlands
68 can support regional sustainability (Seifollahi-Aghmiuni et al., 2019) but are also one of the most vulnerable
69 ecosystems globally (Golden et al., 2017). For instance, human land and/or water use developments (Destouni et al.,
70 2013; Jaramillo and Destouni, 2015; Maneas et al., 2019) in combination with climate variability and change (Orth
71 and Destouni, 2018; Seneviratne et al., 2006) affect large-scale water fluxes with impacts on wetland functions and
72 ecosystem services. These impacts extend over coupled systems of multiple wetlands and the associated total
73 hydrological catchment that integrates these, referred to as a wetlandscape (Thorslund et al., 2017), with even well-
74 intended actions towards various sustainable development goals potentially affecting wetland functions and services
75 in different directions (Jaramillo et al., 2019). As a consequence of various change impacts, wetland areas are now
76 suffering rapid and continued decline in different regions worldwide (Davidson et al., 2018; Davidson, 2014).

77 The scale mismatch between the existing large-scale studies of various landscape changes and the still mostly local
78 wetland impact studies (Thorslund et al., 2017) creates an urgent need for comprehensive, science-based assessment
79 of the interactions between large-scale drivers of change and large-scale wetland systems (Ameli and Creed, 2019;
80 Creed et al., 2017). Adopting a wetlandscape perspective involves moving away from the individual wetland scale to
81 consider the large-scale functioning of the hydrologically coupled system of multiple wetlands and their surrounding
82 landscape. Assessments at these larger scales are needed to enable the formulation of scientific evidence-based
83 guidance and strategies to protect wetlands under global change (Thorslund et al., 2018; Ameli and Creed, 2019). The
84 conceptual framework on wetlandscapes was developed over 30 years ago, by Preston and Bedford (1988), but the
85 dynamics and impacts of many large-scale drivers or functions on wetlandscape scales remain still largely
86 uninvestigated and unknown, with the interactions between large-scale hydroclimatic variability and change and
87 wetland dynamics still being largely underexplored at wetlandscape scale (Thorslund et al., 2017). The combination
88 of high wetland vulnerability and rapid large-scale changes subject to major knowledge and data gaps highlights
89 the need to synthesize and create datasets available for evaluating change effects and feedbacks on the scales of
90 whole wetlandscapes.

91 To address this need and support large-scale studies of whole wetlandscapes in and across different parts of the
92 world, we have created a novel database named as the **Wetlandscape Change Information Database (WetCID)**, for
93 27 wetlandscapes around the world and their associated geographical, wetland, hydrology, hydroclimate, and land use
94 conditions. **WetCID** consists of a survey-based collection of local information and data, combined with compilation
95 and synthesis of gridded large-scale datasets for a range of relevant hydroclimatic and land use variables.

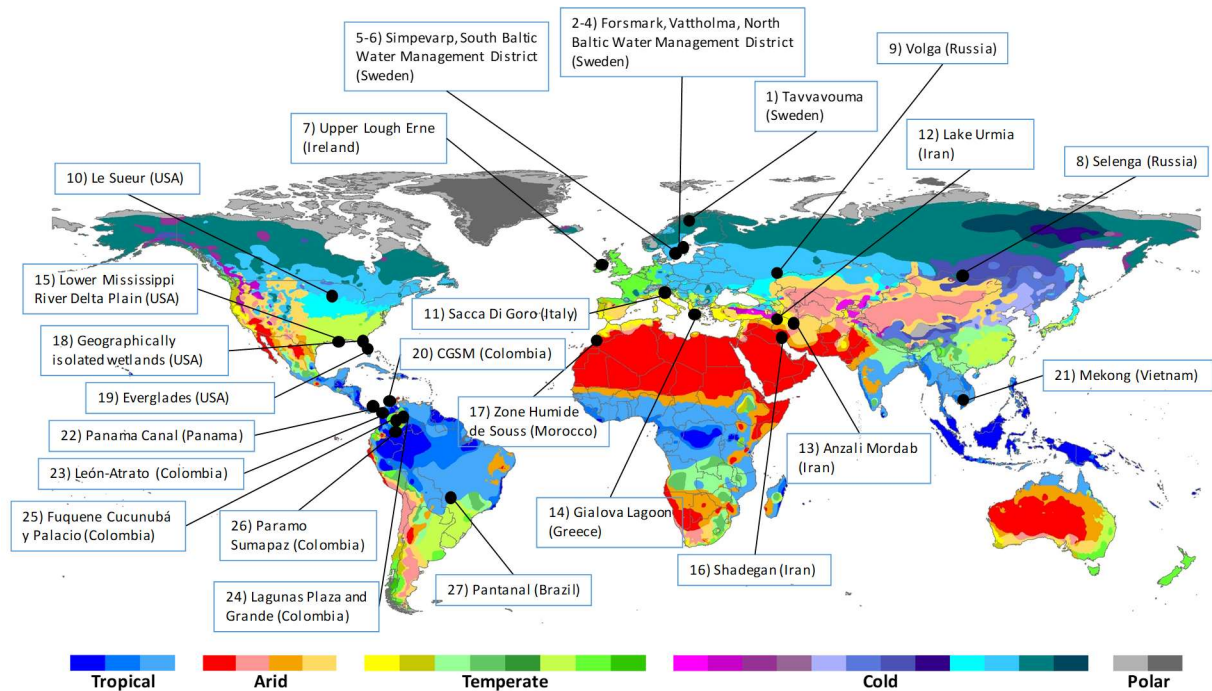
96 The remainder of this paper is structured as follows: In section 2, we describe the methodology used in collecting,
97 processing, and summarizing different datasets. In section 3, we present **WetCID** summaries and sample figures and
98 maps from different components of the underlying datasets, in order to exemplify and highlight the potential of new
99 insights that can be gained from using this database, as well as its limitations. In section 4, we discuss data availability
100 and the format and structure of different files in **WetCID**. Based on the findings, we present some conclusions in
101 section 5.

102 **2 Methods**

105 **2.1 Data acquisition**

106 In compilation of **WetCID** for the 27 wetlandscapes, we employed three sources of primary data. These were: (1)
107 local site survey data, depicting general characteristics of each wetlandscape (catchment) and its geographical
108 characteristics (including shapefiles for its spatial extent) and associated hydrological, climate, and land use conditions
109 and their observed/perceived changes; (2) gridded historical data time series of monthly precipitation and temperature
110 from Climate Research Unit Time-Series (CRU_TS) version 4.02 (Harris et al., 2014); and (3) historical data of annual
111 land cover and its changes from the NOAA-HYDE dataset provided by NOAA's National Climate Data Center (Jain
112 et al., 2013; Meiyappan and Jain, 2012).

113 The survey for local site data (1) was given to researchers within the Global Wetland Ecohydrological Network
114 (GWEN) (www.gwennetwork.se). The GWEN researchers responding to the survey specified the relevant
115 wetlandscape extent (total hydrological catchment with wetlands) and provided boundaries in GIS format for the 27
116 wetlandscapes, located as shown in Figure 1. Information and data of all three types (local survey-based, hydroclimate,
117 land use) were collected and synthesized for each of these wetlandscapes from all three sources (1)-(3). In addition to
118 the local survey information, data on hydroclimate and land use variables were thus also compiled from the global
119 datasets in both gridded and aggregated form for each wetlandscape, as described further in the following.



120
 121 **Figure 1.** Geographical distribution of the 27 wetlandscape sites included in **WetCID**. The background map shows
 122 the Köppen-Geiger climate classification system (as updated by Peel et al., 2007), with the number of wetlandscapes
 123 extended from those included in similar GWEN-site mapping by Thorslund et al. (2017). The site numbering is in
 124 order of latitude from north to south, covering a latitude range from 70°N to 25°S.

125 2.2 Site information surveys

126 A questionnaire for collecting local site knowledge and information on the availability and accessibility of local data
 127 was developed during a GWEN workshop held in Santa Marta, Colombia, on April 24-28, 2018. The questionnaire
 128 was sent out by email after the workshop to all participating GWEN researchers. The researchers responding to it
 129 related their answers to a specific wetlandscape in which they had active research.

130
 131 The questionnaire comprised two main parts. Part 1 contained general questions about the geography, climate,
 132 hydrology, and wetland-relevant human activities and changes in the wetlandscapes. Part 2 focused on the availability
 133 and accessibility of local site data, structured into ‘Hydroclimate’, ‘Land use’, and ‘Other’ data (see templates in the
 134 database files for a full outline of the questionnaire). The collective knowledge obtained on conditions and changes in
 135 the 27 wetlandscapes and on data availability-accessibility is summarized in section 3.1.

136 To complement this local knowledge and information basis, we further extracted and synthesized data for the 27
 137 wetlandscapes from relevant global hydroclimate and land use datasets as described below.

138 2.3 Hydroclimate data

139 The temperature and precipitation data taken from the CRU_TS4.02 global datasets (Harris et al., 2014) covered a 30-
 140 year period (1981-2010), to be consistent with the time span of existing global land use change data. CRU_TS4.02
 141 provides hydroclimate data with spatial resolution of $0.5^\circ \times 0.5^\circ$ and at monthly temporal scale. In preparing
 142 temperature and precipitation datasets for each wetlandscape, the gridded data within the area of the wetlandscape
 143 were extracted from the global datasets and also spatially aggregated over that area, based on area-weighted averaging
 144 over the grid cells covered by the shapefile of each wetlandscape (catchment). This provided wetlandscape-specific
 145 data time series for each variable at each grid cell and aggregated over the whole wetlandscape. To facilitate analyses
 146

147 at different spatial resolutions, both the gridded and the aggregated time series were included in **WetCID** for each of
148 the 27 wetlandscapes.

149 In addition to the gridded and aggregated data time series, period-specific temperature and precipitation changes were
150 also calculated for each wetlandscape, by dividing the total 30-year time span of the collected data into the two 15-
151 year periods 1981-1995 (Per1) and 1996-2010 (Per2). Such period-specific change quantification can facilitate
152 relatively simple and straightforward analysis of how these hydroclimatic changes correlate with and may have driven
153 other wetlandscape changes (e.g., in runoff, evapotranspiration, wetland area) between the same time periods
154 (Destouni et al., 2013; Jaramillo and Destouni, 2014, 2015). Absolute and relative (%) changes between these periods
155 (*AbsChng* and *RelChng*, respectively) were calculated from the mean annual values of temperature and precipitation
156 during Per1 and Per2, as:

$$AbsChng = \overline{Var}_{Per2} - \overline{Var}_{Per1} \quad (1)$$

$$RelChng = \frac{\overline{Var}_{Per2} - \overline{Var}_{Per1}}{\overline{Var}_{Per1}} \times 100 \quad (2)$$

157 where \overline{Var}_{Per1} and \overline{Var}_{Per2} are average temperature (in C°) or precipitation (in mm/yr) over Per1 (1981-1995) and
158 Per2 (1996-2010), respectively. Eq. (1) was applied to both temperature and precipitation data, to calculate their
159 absolute changes in each wetlandscape, while Eq. (2) was only applied to precipitation data, to calculate the
160 corresponding percentage change in precipitation.

161 2.4 Land use data

162 The NOAA-HYDE dataset was used to estimate land uses and their changes in each wetlandscape. NOAA-HYDE
163 estimates annual changes in land cover area over the global land mass, starting from a base map for year 1765. The
164 estimations follow a predefined pathway, determined by relevant land use/management datasets (cropland,
165 pastureland, urbanization, timber harvesting), to obtain forest area distributions close to satellite-based estimates of
166 forests in recent years (Meiyappan and Jain, 2012). NOAA-HYDE data cover the period 1770-2010 with yearly
167 temporal resolution and spatial resolution of $0.5^\circ \times 0.5^\circ$, from which data for the period 1981-2010 were used for the
168 development of this database, in consistency with the hydroclimate data period described above.

170 The NOAA-HYDE land cover maps show the percentage of grid cell area containing 28 different land cover types
171 (see Table A1 in Appendix A). In this study, we reclassified these 28 land cover types into 10 distinct land covers:
172 urban, shrubland, grassland, pastureland, cropland, forest, water, desert, tundra, and savannah, by combining similar
173 land cover classes (see Table A1). As done for the hydroclimate data, the gridded land use data were also spatially
174 aggregated over each wetlandscape based on the area-weighted averaging method (with weights of specific land-cover
175 area in each grid cell relative to total wetlandscape area). This provided a wetlandscape-specific data time series of
176 annual land use/cover, for each of the reclassified 10 land cover types. The final **WetCID** files comprised gridded time
177 series data on absolute grid cell area (in km²) covered by each land cover type, time series data on percentage of grid
178 cell area covered by each land cover type, and aggregated absolute and percentage time series data for each
179 wetlandscape area.

180 In analogy with the hydroclimatic changes, period-specific change quantification can facilitate relatively simple and
181 straightforward analysis of how different types of land use changes between time periods correlate with and may have
182 driven associated wetlandscape changes (Destouni et al., 2013; Jaramillo and Destouni, 2015). Eq. (1) was therefore
183 also used to calculate absolute change in the area of each land cover type (km²) within each wetlandscape between
184 Per1 (1981-1995) and Per2 (1996-2010). In the land use case, \overline{Var}_{Per1} and \overline{Var}_{Per2} represent annual average area
185 covered by a land cover type within each wetlandscape during Per1 and Per2, respectively. Furthermore, the
186 corresponding change in relative land cover area (*ChngRel* in %-points of total wetlandscape area) was calculated as:

$$ChngRel = \frac{\overline{Var}_{Per2} - \overline{Var}_{Per1}}{Area_c} \times 100 \quad (3)$$

187 where $Area_c$ is the total wetlandscape (catchment) area in km^2 and \overline{Var}_{Per1} and \overline{Var}_{Per2} are the annual average areas
 188 covered by each land cover type in the wetlandscape during Per1 and Per2, respectively.

189 3 Results

190 3.1 Site information surveys

191 Table 1 summarizes some general geographical, climate, and wetland type information provided by GWEN
 192 researchers in the survey information forms. Each site represents either an individual wetland or a wetlandscape (e.g.,
 193 a catchment) including multiple wetlands. The country, main climate zone and wetland area relative to total
 194 wetlandscape (catchment) area are also given for each site in Table 1. Moreover, a summary of the availability-
 195 accessibility of local data on the wetlands, hydrology, climate, and land uses, as well as the wetlandscape (catchment)
 196 area in each of the 27 wetlandscapes is also shown in Figure 2. The variables of evapotranspiration and soil moisture
 197 were revealed as having large data gaps (red color in Figure 2), indicating an overall need to use other data sources
 198 (e.g., gridded global data products) for quantifying these variables and associated processes. Figure 2 also highlights
 199 the variability in data availability and open accessibility among the sites. For instance, no open data sources have been
 200 reported for the considered variables in the arid subtropical sites 13, 16, and 17, whereas open data sources have been
 201 reported for most variables in the cold Swedish sites 4 and 6, and the American subtropical sites 15 and 19.

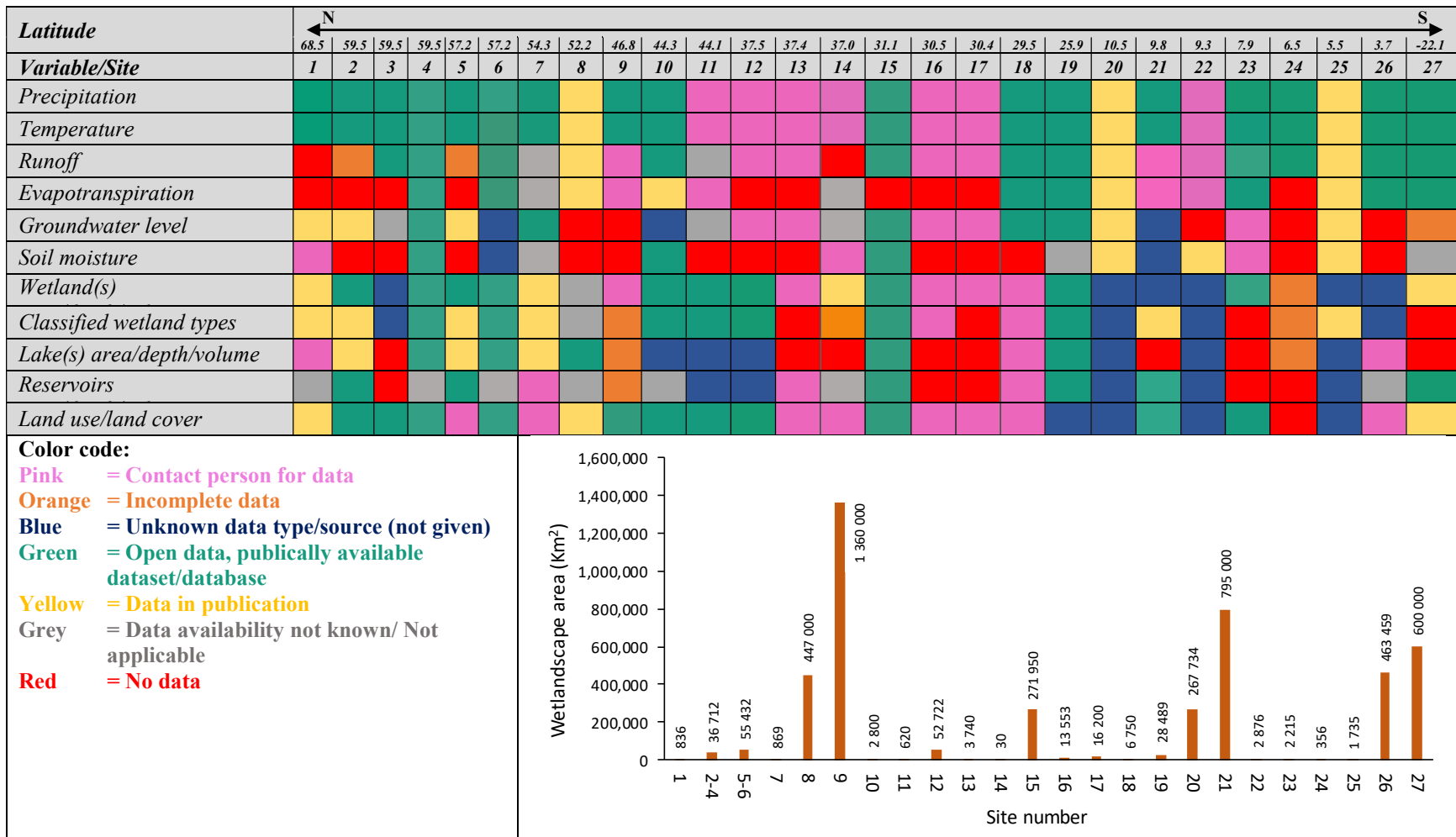
202 The synthesized survey dataset also contains information about different types of wetland, hydroclimatic and/or land
 203 use changes observed/perceived to have occurred in the 27 investigated wetlandscapes (Figure 3). Substantial changes
 204 are reported for most of these wetlandscapes, but a few sites have no known changes (e.g., in the arid Moroccan site
 205 17) or have important knowledge gaps regarding changes (e.g., in the cold Swedish sites 2 and 5, even though
 206 availability to at least some data is relatively good there). The information on local data availability-accessibility
 207 (Figure 2) and observed/perceived change occurrence (Figure 3) summarised and structured in WetCID can guide
 208 further study directions, and support identification of key needs for complementary new local data and/or use of
 209 additional large-scale (regional-global) gridded data. Furthermore, the wetlandscapes of WetCID are located in
 210 different regions of the world, with seven sites in Northern Europe (sites 1-7), seven in the Amazon and Caribbean
 211 region (sites 20 and 23-27), four in North America (sites 10, 15, 18, and 19), three in the Middle East (sites 12, 13,
 212 and 16), two in the Mediterranean region (sites 11 and 14), two in Siberia (sites 8 and 9), and two more in other parts
 213 of the world (Northern Africa and East Asia). As such, regional patterns and characteristics can be identified, and
 214 regional strategies developed, e.g., to enhance availability of data and information, and determine further research
 215 needed to bridge region-specific knowledge gaps and decide on relevant management plans for each region's wetland
 216 ecosystems. Such regional characterizations and assessments can be initialized with the current version of WetCID
 217 and further updated as more data for already included and possible additional regional wetlandscapes become available
 218 in future database versions.

219

220
221**Table 1.** General geographic, climate, and wetland type information for the 27 investigated wetlandscapes in WetCID. The data and information are based on survey responses by researchers with active research (on various topics) at each wetlandscape site.

Site No.	Site name	Country	Classification	Climate zone	Wetland type	Area of wetlands relative to total catchment/wetlandscape area (%)
1	Tavvavouma	Sweden	Wetlandscape	Subarctic	Peat plateau/thermokarst lake complex	2.8
2	Forsmark	Sweden	Wetlandscape	Humid continental (cold summer)	Bogs, fens, marshes, (shallow lakes)	0.01
3	Vattholma	Sweden	Wetlandscape	Humid continental (cold summer)	Bog, Fen, Riparian	-
4	North Baltic WMD	Sweden	Wetlandscape	Humid continental (cold summer)	Multiple	100
5	Simpevarp	Sweden	Wetlandscape	Humid continental (cold summer)	Bogs, fens	0.01
6	South Baltic WMD	Sweden	Wetlandscape	Humid continental (cold summer)	Multiple	100
7	Upper Lough Erne	Ireland	Individual wetland	Cold (dry winter, cold summer)	Flood plain/shallow lakes	22
8	Selenga	Russia	Wetlandscape	Cold (dry winter, cold summer)	Marshes (Riverine, Palustrine)	0.13
9	Volga	Russia	Wetlandscape	Cold (dry winter, cold summer)	Marshes (Riverine, Palustrine)	1.0
10	Le Sueur	USA	Wetlandscape	Temperate	isolated, fluvial/riparian, lakes/ponds, marshes, forest/shrubs, constructed	100
11	Sacca Di Goro	Italy	Individual wetland	Cold-summer Mediterranean	Shallow saltwater coastal lagoon	4.2
12	Lake Urmia	Iran	Individual wetland	Continental	Lake	8.8
13	Anzali Mordab	Iran	Individual wetland	Caspian or Hyrcanian climate	Inland and Marine/Coastal wetland	4.0
14	Gialova Lagoon	Greece	Individual wetland	Hot-summer Mediterranean	Coastal wetland	13
15	Lower Mississippi River Delta Plain	USA	Wetlandscape	Humid Subtropical	Riverine, Marine, Estuarine, Lacustrine	3.5
16	Shadegan	Iran	Individual wetland	Warm desert	Palustrine, Estuarine, Marin	31
17	Zone Humide de Souss	Morocco	Individual wetland	Mediterranean semi-arid	marine and coastal	0.01
18	Geographically isolated wetlands	USA	Wetlandscape	Humid subtropical	Freshwater marshes and swamps	100
19	Everglades	USA	Individual wetland	Tropical to Subtropical	Freshwater wetland, coastal wetland	32
20	CGSM	Colombia	Individual wetland	Tropical	Estuarine	-
21	Mekong Delta	Vietnam	Wetlandscape	Tropical Monsoon	Marine	5.0
22	Panama Canal	Panama	Wetlandscape	Tropical/Central America	River Chagres, Lake	100
23	León-Atrato	Colombia	Wetlandscape	Tropical rainforest	Marshes and Swamps	17
24	Lagunas Plaza and Grande	Colombia	Wetlandscape	Extremely cold and very dry	Glacial Lake	4.4
25	Fúquene, Cucunubá y Palacio	Colombia	Individual wetland	Cold and very dry	Natural shallow lake	1.7
26	Paramo Sumapaz	Colombia	Wetlandscape	Tropical	High altitude wetland	46
27	Pantanal	Brazil	Wetlandscape	Tropical savanna with dry-winter	Periodically inundated savanna	27

222



223 **Figure 2.** Availability-accessibility (color-coded) of site-specific climate and land use data for the 27 investigated wetlandscapes in WetCID, and associated
 224 wetlandscape area for each site (lower right diagram). The data availability-accessibility classification (color codes) is based on the survey responses by researchers
 225 with active research (on various topics) at each wetlandscape site.

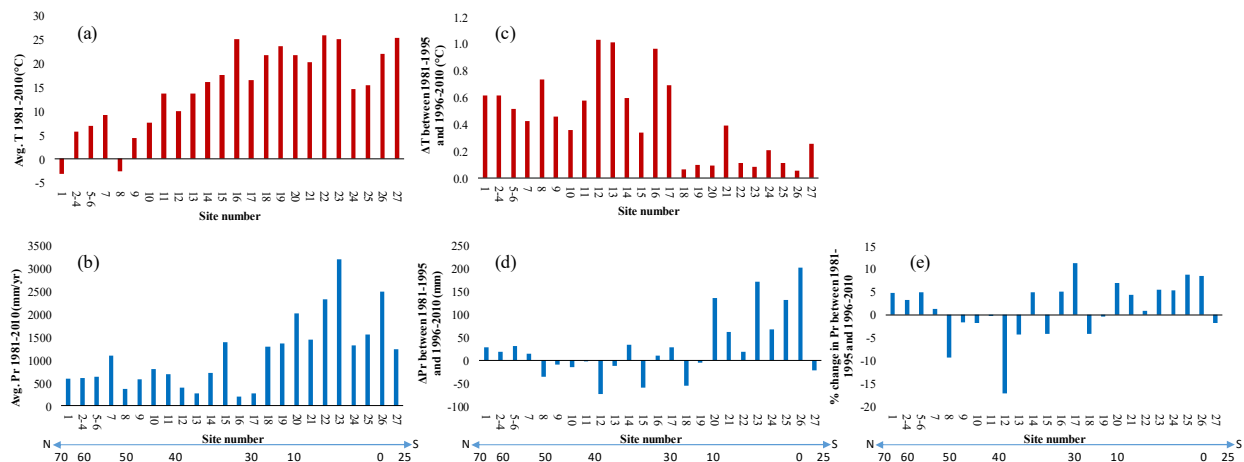
Latitude	← N →																											S →
	68.5	59.5	59.5	59.5	57.2	57.2	54.3	52.2	46.8	44.3	44.1	37.5	37.4	37.0	31.1	30.5	30.4	29.5	25.9	10.5	9.8	9.3	7.9	6.5	5.5	3.7	-22.1	
Variable/Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	
<i>Q1</i>	Blue	Red	Red	Blue	Red	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Green	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Red	Blue	Blue	
<i>Q2</i>	Green	Grey	Red	Blue	Grey	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Green	Blue	Blue	Blue	Green	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Red	Blue
<i>Q3</i>	Blue	Grey	Green	Blue	Grey	Blue	Blue	Grey	Blue	Blue	Red	Blue	Blue	Blue	Blue	Blue	Green	Blue	Blue	Blue	Blue	Blue	Blue	Green	Blue	Red	Green	
<i>Q4</i>	Blue	Grey	Green	Blue	Grey	Blue	Grey	Blue	Blue	Blue	Blue	Blue	Green	Blue	Blue	Blue	Green	Blue	Green	Blue	Grey	Green	Blue	Blue	Red	Blue	Blue	
<i>Q5</i>	Green	Green	Blue	Blue	Green	Blue	Green	Green	Blue	Green	Red	Blue	Blue	Green	Red	Green	Green	Blue	Blue	Blue	Blue	Red	Blue	Green	Green	Blue	Green	
<i>Q1</i> : Are any changes known to have occurred in the wetlands? <i>Q2</i> : Is there information on considerable land use/cover changes in the watershed? <i>Q3</i> : Is there information on considerable wetland changes (e.g., change in wetland distribution, coverage, etc.) in the watershed? <i>Q4</i> : Have any considerable hydroclimate changes been observed and reported for your site? <i>Q5</i> : Are there any man-made reservoirs in the watershed?																	Color code: Blue = Yes Green = No Red = Blank Grey = Don't know											

226
227

Figure 3. Knowledge status regarding observed/percieved changes occurring in the 27 investigated wetlandscapes in **WetCID**. The color-coded status classification is based on survey responses by researchers with active research (on various topics) at each wetlandscape site.

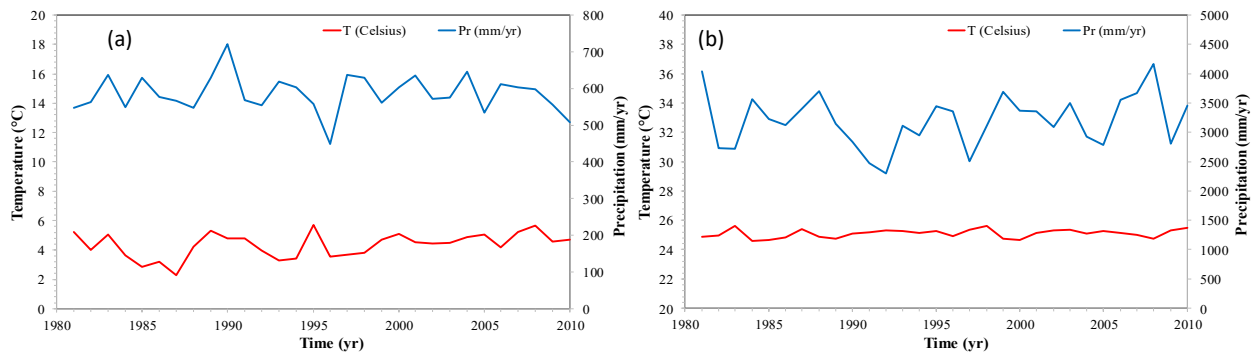
228 3.2 Hydroclimatic data

229 Data for long-term average temperature and precipitation conditions, and changes in these between Per1 (1981-1995)
230 and Per2 (1996-2010) at the 27 wetlandscape sites are presented in Figure 4. The horizontal axis in the diagrams shows
231 the wetlandscape site numbers in order of their latitude from north to south, covering the latitude range from 70°N to
232 25°S. The increase in average temperature and precipitation with decreasing latitude (Figure 4a, 4b) illustrates that
233 the wetlandscapes also cover a wide range of hydroclimate conditions, from low to high temperature and precipitation
234 values (see also Figure 1). Temperature has increased over almost all wetlandscapes, and considerably more so in the
235 more northern and colder areas than in the warmer areas around and south of the equator (Figures 4a-b). In contrast,
236 precipitation changes are relatively small, varying around zero, in the more northern, colder as well as drier areas,
237 while precipitation has mostly increased in the warmer and also wetter areas around and south of the equator (Figures
238 4c-4e). Overall, the changes in mean annual temperature range from zero to +1°C while the changes in precipitation
239 range from -70 mm/yr to +170 mm/yr, with the Iranian site 12 (Lake Urmia catchment) exhibiting the greatest increase
240 in temperature (+1°C) and the greatest relative decrease in precipitation (-17%).

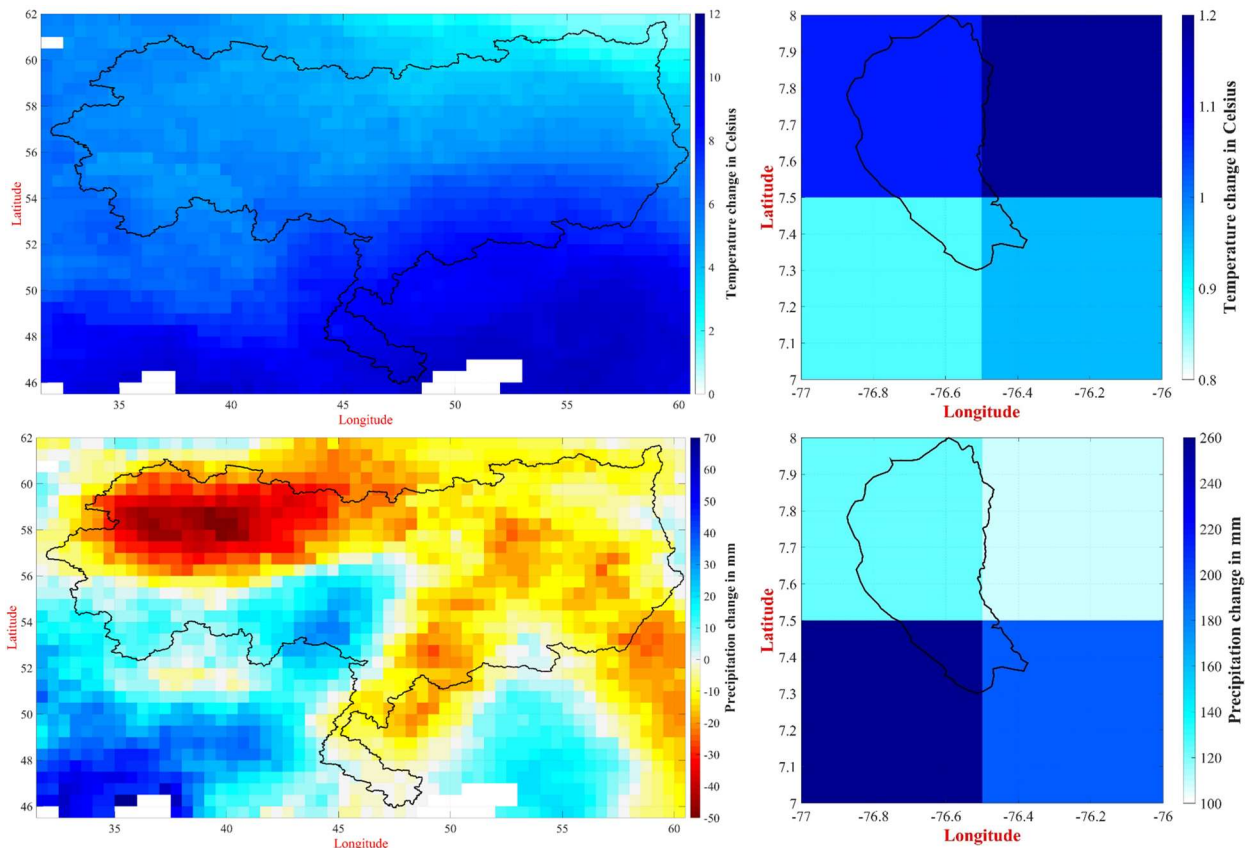


241 **Figure 4.** Overview of hydroclimate conditions and their changes in the 27 wetlandscapes. Long-term average (1981-
242 2010) (a) temperature and (b) precipitation. Absolute change between Per1 (1981-1995) and Per2 (1996-2010) in (c)
243 mean annual temperature and (d) mean annual precipitation. (e) Relative change in precipitation. The horizontal axis
244 shows the numbering of the 27 wetlandscapes, sorted in order of their latitude from North to South.
245

246
247 Figures 5 and 6 exemplify gridded variability and change data for temperature and precipitation over the Volga (no.
248 9) and the León-Atrato (no. 23) wetlandscapes. The data time series of wetlandscape-aggregated annual average
249 temperature and precipitation in these wetlandscapes (Figure 5) exemplify such data prepared and included in **WetCID**
250 for all 27 wetlandscapes. These two wetlandscapes were chosen for data exemplification because they represent
251 different hydroclimatic conditions, with Volga being cold and dry while León-Atrato is warm and wet (Figure 5), as
252 well as have different sizes with Volga being the largest (1,360,000 km²) and León-Atrato (2,344 km²) one of the
253 smallest studied wetlandscapes. The data for these examples (Figure 5) are consistent with corresponding data
254 implications across the different wetlandscapes over the world (Figure 4) in indicating an overall positive (warmer-
255 wetter) spatial correlation between long-term average temperature and precipitation. Temporally, however, the recent
256 changes in these variables imply a negative correlation (towards warmer and mostly drier conditions) for the Volga
257 wetlandscape (Figure 6, left) as for several other northern wetlandscapes in **WetCID** (Figure 4). In contrast, a positive
258 correlation (towards mostly warmer and wetter conditions) is implied by the recent temporal changes in the León-
259 Atrato wetlandscape (Figure 6, right) as one of the most southern wetlandscapes in **WetCID** (Figure 4). Such
260 spatiotemporal sign shifts and dipole emergence in temperature-precipitation correlations have been noted in other
261 recent studies of long-term variations and short-term changes of hydroclimate over Europe (Charpentier Ljungqvist
262 et al., 2019). **WetCID** can facilitate further studies of these correlation conditions for and across the different
263 wetlandscapes around the world.



264
265 **Figure 5.** Variability in wetlandscape-aggregated annual average temperature and precipitation for the examples of
266 the (a) Volga and (b) León-Atrato wetlandscapes.
267

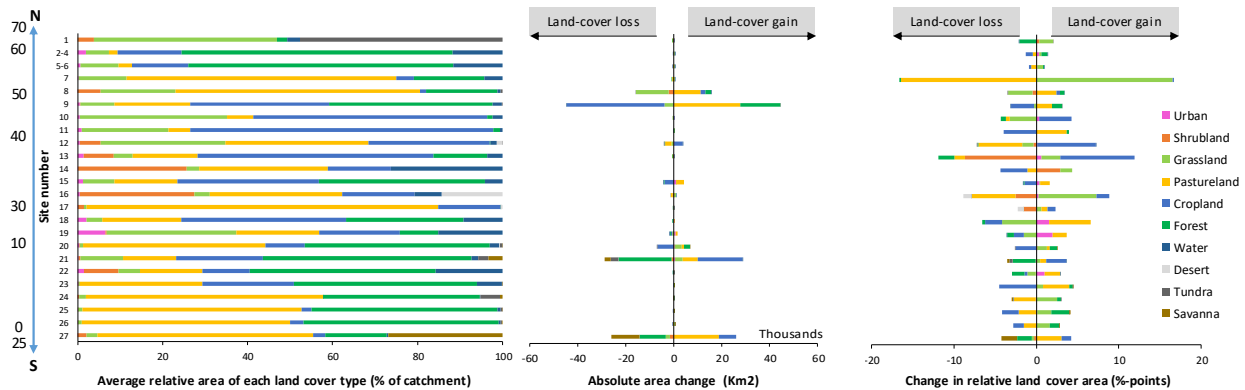


268
269 **Figure 6.** Maps showing gridded absolute change in (upper diagrams) temperature and (lower diagrams) precipitation
270 for the examples of the (left) Volga and (right) León-Atrato wetlandscapes. Absolute change values have been
271 calculated by applying Eq. (1) on each grid cell within a wetlandscape.
272

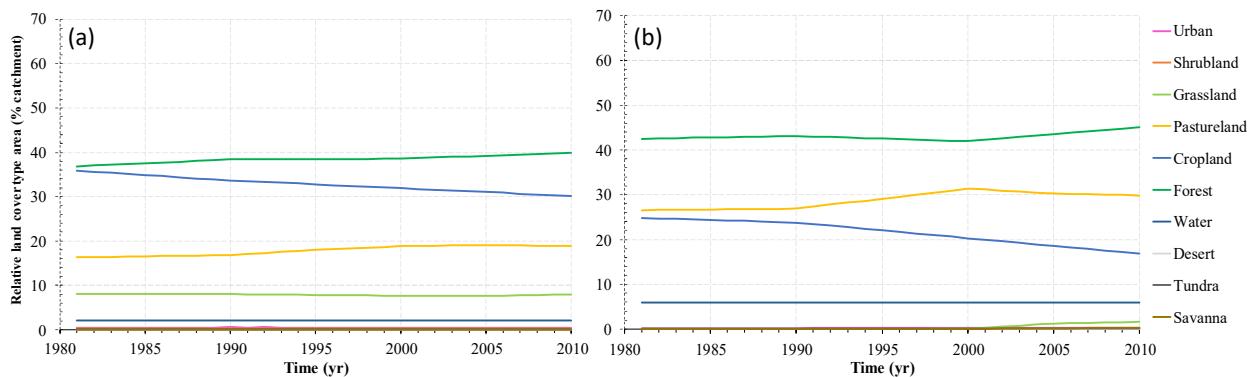
273 The data for the Volga and León-Atrato examples also emphasize that wetlandscapes can have very different area
274 extents (spatial scales), with potentially important implications for the spatial resolution (Figure 6) and related
275 usefulness of data provided in **WetCID**. For example, the Volga wetlandscape includes 982 grid cells with complete
276 or partial coverage in the hydroclimate datasets, while the León-Atrato wetlandscape only includes 4 such grid cells.
277 Most of the available global datasets from climate and earth system models have coarser spatial resolution than the
278 size of most individual wetlands. Thus, model data for individual wetlands are subject to high uncertainty, whereas
279 data aggregated over whole wetlandscapes have greater potential for accuracy (Bring et al., 2015), highlighting the
280 need for considering the whole-wetlandscape scales in assessments of how wetland systems interact with hydroclimate
281 and land use changes.

282 **3.3 Land use data**

283 The aggregated and gridded land use data in **WetCID** can also be used for different types of whole-wetlandscape
 284 analyses. Figure 7 summarises the data for long-term average relative area of each land cover type (% of total
 285 wetlandscape area), and associated absolute area changes (km²) and changes in relative area coverage (%-points of
 286 total wetlandscape area) for different land cover types across the 27 wetlandscapes. The data reveal, for example, the
 287 high percentage of forest area in wetlandscapes at high latitudes and in the tropics, while relative cropland area
 288 increases towards the temperate regions (Figure 7, left). Figure 7 also summarises the different types of land cover
 289 transformations, for example from: ‘forest’ into ‘cropland and pastureland’ in the tropical Mekong wetlandscape 21;
 290 ‘pastureland’ into ‘grassland’ in the temperate Irish wetlandscape 7 and into ‘cropland’ in the borderline cold-dry
 291 Iranian wetlandscape of the dramatically shrinking Lake Urmia 12 (Khazaei et al., 2019); ‘shrubland’ into ‘cropland’
 292 in the borderline temperate Iranian wetlandscape 13; ‘cropland’ into ‘shrubland’ in the warm temperate Greek
 293 wetlandscape 14.
 294



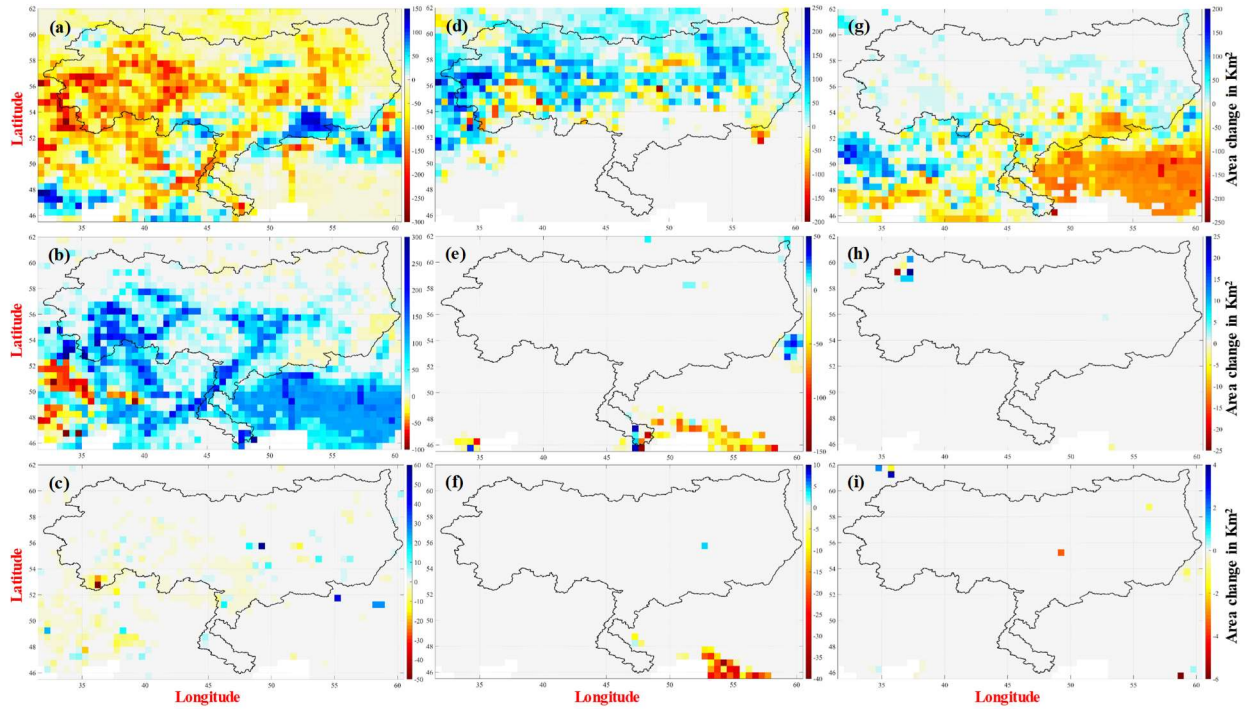
295 **Figure 7.** (Left) Long-term average relative area of each land cover type (percentage of total wetlandscape area).
 296 (Center) Absolute change in area of each land cover type (km²). (Right) Change in relative land cover area (%-points
 297 in relation to total catchment area). The summarized and illustrated data are for the 27 wetlandscapes included in
 298 **WetCID**.
 299



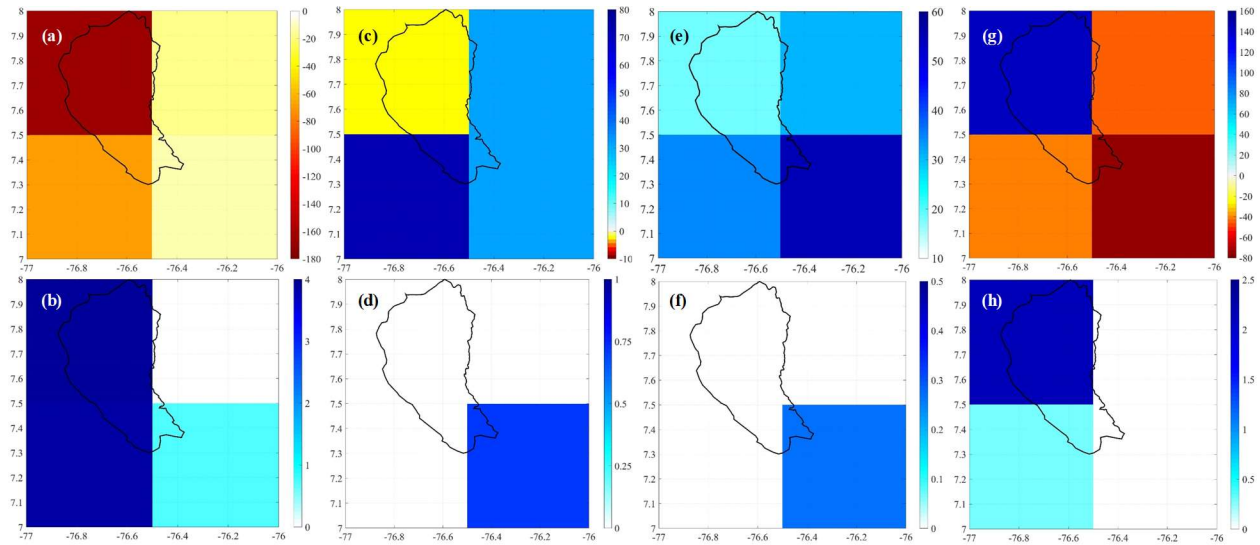
300 **Figure 8.** Data time series for wetlandscape-aggregated annual average area (relative to total wetlandscape area, in %)
 301 for different land cover types in the (a) Volga and (b) León-Atrato wetlandscapes.
 302

303 The data time series of different land covers and their changes between Per1 (1981-1995) and Per2 (1996-2010) show,
 304 for example, forest and (decreasing) cropland, followed by pastureland and grassland, to be dominant in the large
 305 Volga wetlandscape, while forest, pastureland and (decreasing) cropland areas dominate the small León-Atrato
 306 wetlandscape (Figure 8). Gridded maps of land cover area changes in these wetlandscape examples (Figures 9-10)
 307 again demonstrate large spatial resolution differences with potentially important implications for the usefulness of
 308 land use datasets for wetlandscapes of smaller scale. For example, in the most northern Swedish-Arctic wetlandscape
 309

310 1, grassland is obtained as the second dominant landcover type after tundra (Figure 7, left plot), which is not normally
 311 seen in this northern Arctic region.



312
 313 **Figure 9.** Gridded maps of absolute area changes (in km²) for (a) cropland, (b) pasturland, (c) urban, (d) forest, (e)
 314 shrubland, (f) desert, (g) grassland, (h) tundra, and (i) water land cover types between Per1 (1981-1995) and Per2
 315 (1996-2010) in the Volga wetlandscape example.
 316



317
 318 **Figure 10.** Gridded maps of absolute area changes (in km²) for (a) cropland, (b) savanna, (c) forest, (d) shrubland, (e)
 319 grassland, (f) tundra, (g) pasturland, and (h) urban land cover types between Per1 (1981-1995) and Per2 (1996-2010)
 320 in the León-Atrato wetlandscape example.

321 **4 Data availability**

322 The complete **WetCID** database includes five file categories (<https://doi.pangaea.de/10.1594/PANGAEA.907398>;
323 Ghajarnia et al., 2019).

324

325 ***Folder 1: Survey results (Summary documents A, B, C)***

326 These three summary documents (all in Excel) were created from responses obtained in the main survey of GWEN
327 researchers (see survey template/structure in **WetCID** files). Summary document A contains summarized site-specific
328 information on the wetlands, hydrology, climate and land uses in each of for the 27 wetlandscapes. Summary
329 documents B and C contain local knowledge relating to the availability-accessibility (or lack) of land use and
330 hydroclimatic data, respectively, for each of the 27 wetlandscapes.

331

332 ***Folder 2: Gridded land use and hydroclimatic datasets (NetCDF database files)***

333 In **WetCID**, there is a separate NetCDF file for each wetlandscape that contains a complete set of gridded hydroclimate
334 and land use data time series for the closest rectangular window around the catchment polygon of the wetlandscape.
335 The gridded hydroclimate datasets were created by subsetting the CRU_TS4.02 original global datasets over the area
336 of each wetlandscape (catchment). The gridded land use dataset for each wetlandscape (catchment) was created by
337 first reclassifying the land cover types and then subsetting the global gridded data. All these gridded data time series
338 are saved in separate NetCDF files for each wetlandscape, which is an appropriate file type for storing gridded data.
339 Each NetCDF file contains 18 variables, including hydroclimate, land cover, and some auxiliary variables. Appendix
340 B presents the general attributes table (Table B1) and information and explanations of all 18 variables included in the
341 NetCDF database files (Table B2). Sample Matlab and R codes for reading and extracting data from the NetCDF files
342 are also provided in Appendix C.

343

344 ***Folder 3: Aggregated land use and hydroclimate data (Excel databases)***

345 The time series of land use and hydroclimatic data aggregated over each wetlandscape (catchment) were created from
346 the gridded datasets (NetCDF files) and stored as Excel files for each wetlandscape. The Excel file for each
347 wetlandscape contains three sheets: 1) Annual time series of covered area by each land cover type in km², 2) time
348 series of annual relative area (%) occupied by each land cover type, and 3) time series of monthly temperature (°C)
349 and precipitation (mm/month) data.

350

351 ***Folder 4: Geographical dataset in a zip file (shapefiles)***

352 To perform any spatial analysis of the wetlandscapes, one needs to have access to the shapefile and polygons of the
353 wetlandscape (catchment) and wetlands within it. These shapefiles were provided by the GWEN researchers and can
354 be downloaded from **WetCID** files.

355

356 ***Folder 5: Summary tables of changes in hydroclimatic and land use variables***

357 Absolute and relative changes in all considered hydroclimate and land use variables between Per1 (1981-1995) and
358 Per2 (1996-2010) were calculated using Eq. (1), (2), and (3) for each wetlandscape. The results are summarized in an
359 Excel file with two sheets for each wetlandscape: 1) Absolute changes in temperature, precipitation and land cover
360 area, and 2) relative changes in precipitation and land cover area. The data for land cover changes are provided for all
361 considered land use variables.

362

363 **5 Conclusions**

364 The presented new database (**WetCID**) combines survey-based local information and knowledge with gridded large-
365 scale hydroclimate and land use datasets for 27 wetlandscapes around the world. The gridded datasets contain 30-year
366 time series of mean monthly precipitation and temperature, along with annual average land uses and their changes
367 over this time period for each wetlandscape. **WetCID** can support site assessments, cross-regional comparisons, and
368 scenario analyses of the roles and impacts of various land use, hydroclimatic and wetland conditions and their changes

369 on whole-wetlandscape functions and associated ecosystem services. The information on local data
370 availability/accessibility and observed/perceived change occurrence summarised and structured in **WetCID** can guide
371 further study directions and support identification of key needs for complementary new local data and/or use of
372 additional regional-global gridded datasets.

373 The gridded large-scale hydroclimatic and land use data included in **WetCID** have been derived using open data
374 sources and processed with open-source tools, while **WetCID** has been designed so that more data can readily be
375 added to it. The site-specific usefulness of different included data varies for wetlandscapes of different scales, but
376 **WetCID** can be updated with small time investment as new datasets become available, or current datasets are expanded
377 or refined.

378

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382 National Climatic Data Center (<http://www.ncdc.noaa.gov/>). The temperature and precipitation data was also retrieved
383 from the CRU_TS4.02 global database (<https://crudata.uea.ac.uk/cru/data/hrg/>). The data of Selenga and Volga
384 wetlandscapes were prepared within RFBR project 17-29-05027 and 18-05-60219. Travel to the workshop was made
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387 Southeast Environmental Research Center at Florida International University).

388

389 **Author contributions**

390 N.G. compiled the climate and land use database, contributed to the communication with other co-authors for
391 the wetlandscape data collection, and was main responsible for analyzing the data and writing the paper. G.D.
392 conceived and led the study and the development of **WetCID** and analysis approach, led the communication with other
393 co-authors, and contributed to the result analysis and writing of the paper. J.T. conceived the idea of the data paper
394 type, was main responsible for collecting and compiling the local survey information and its summary and analysis in
395 the paper, and contributed to communication with co-authors, the result analysis and the writing. Z.K. contributed to
396 the communication with co-authors, the database development, and the result analysis and writing. All other co-
397 authors contributed by providing local site information in the survey forms and/or taking part in discussions for
398 planning and outlining the study.

399

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483 **Appendix A: Summary of land cover type parameters**484 **Table A1.** List of all different land cover types included in the NOAA-HYDE dataset and their corresponding
485 reclassified category in WetCID

Number	Land Cover Name	Description	Reclassified Category
1	TrpEBF	Tropical Evergreen Broadleaf Forest	Forest
2	TrpDBF	Tropical Deciduous Broadleaf Forest	Forest
3	TmpEBF	Temperate Evergreen Broadleaf Forest	Forest
4	TmpENF	Temperate Evergreen Needleleaf Forest	Forest
5	TmpDBF	Temperate Deciduous Broadleaf Forest	Forest
6	BorENF	Boreal Evergreen Needleleaf Forest	Forest
7	BorDNF	Boreal Deciduous Needleleaf Forest	Forest
8	Savannah	Savannah	Savannah
9	C3grass	C3 Grassland/Steppe	Grassland
10	C4grass	C4 Grassland/Steppe	Grassland
11	Denseshrub	Dense Shrubland	Shrubland
12	Openshrub	Open Shrubland	Shrubland
13	Tundra	Tundra	Tundra
14	Desert	Desert	Desert
15	PdRI	Polar Desert/Rock/Ice	Desert
16	SecTrpEBF	Secondary Tropical Evergreen Broadleaf Forest	Forest
17	SecTrpDBF	Secondary Tropical Deciduous Broadleaf Forest	Forest
18	SecTmpEBF	Secondary Temperate Evergreen Broadleaf Forest	Forest
19	SecTmpENF	Secondary Temperate Evergreen Needleleaf Forest	Forest
20	SecTmpDBF	Secondary Temperate Deciduous Broadleaf Forest	Forest
21	SecBorENF	Secondary Boreal Evergreen Needleleaf Forest	Forest
22	SecBorDNF	Secondary Boreal Deciduous Needleleaf Forest	Forest
23	Water	Water/Rivers	Water
24	C3crop	C3 Cropland	Cropland
25	C4crop	C4 Cropland	Cropland
26	C3past	C3 Pastureland	Pastureland
27	C4past	C4 Pastureland	Pastureland
28	Urban	Urban land	Urban

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Appendix B: Description of parameters included in the NetCDF database files of WetCID

Table B1. General attributes table for NetCDF database files of WetCID

Item	Description
project_name	Global Wetland Ecohydrology Network (GWEN) – An Agora for Scientists and Study Sites
project_summary	GWEN consists of a network of wetland researchers at study sites around the world, who are all interested in sharing, investigating, and applying research to improve knowledge on the large-scale function of, and changes to, wetland ecosystems.
project_website	http://www.gwennetwork.se/
dataset	land use and climate data for the catchments of wetlands included in GWEN
comment	The dataset in this NetCDF file is created to represent the change in land use and land cover over the catchment area of each wetland site included in the GWEN project. Precipitation and temperature time series data are also included for climate considerations.
land use data_reference	NOAA-Historical Land-Cover Change and Land-Use Conversions Global Dataset_HYDE version (https://data.nodc.noaa.gov/cgi-bin/iso?id=gov.noaa.ncdc:C00814)
climate data_reference	Climate Research Unit (CRU) data CRU_TS v. 4.02 (https://crudata.uea.ac.uk/cru/data/hrg/cru_ts_4.02/)
license	please quote the following citation when using data:
data_type	grid
spatial_resolution	0.5x0.5 degrees latitude/longitude
institution	Dept. of Physical Geography, Stockholm University, Sweden
time_coverage_start	1981
time_coverage_end	2010
time_coverage_resolution	yearly for land cover data and monthly for climate data
date_created	May-19
core group of researchers determining the dataset	Georgia Destouni, Navid Ghajarnia, Zahra Kalantari, Josefin Thorslund
creator name	Navid Ghajarnia

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490 **Table B2.** List and description of land use and hydroclimate variables included in the NetCDF database files of
 491 WetCID

Number	Variable Name	Variable Long Name	Variable Explanation
1	longitude	longitude	degrees_east
2	latitude	latitude	degrees_north
3	time_LCD	time for land cover datasets	years since, 1 January 0001
4	time_CD	time for climate datasets	days since 1900-1-1
5	Mask	Grids that have/have not overlap with catchment area	catchment area binary mask [0,1]
6	Area	Area of land grid cells	Units are in km ²
7	Urban	Urban land cover type	Units are in percentage of grid cell area
8	Shrubland	Open/dense shrubland land cover type	Units are in percentage of grid cell area
9	Grassland	Grassland/steppe land cover type	Units are in percentage of grid cell area
10	Pastureland	Pastureland land cover type	Units are in percentage of grid cell area
11	Cropland	Cropland land cover type	Units are in percentage of grid cell area
12	Forest	Tropical, Temperate, Boreal Evergreen, Deciduous Broadleaf, Needleleaf Forest land cover type	Units are in percentage of grid cell area
13	Water	Water/rivers land cover type	Units are in percentage of grid cell area
14	Desert	Desert/polar desert/rock/ice land cover type	Units are in percentage of grid cell area
15	Tundra	Tundra land cover type	Units are in percentage of grid cell area
16	Savannah	Savannah land cover type	Units are in percentage of grid cell area
17	Prcp	Precipitation	Units are in mm/month
18	Tmp	Near-surface temperature	Units are in degrees Celsius

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493 **Appendix C: Sample codes to read NetCDF database files included in WetCID**

494 Matlab Sample code:

495 info = ncinfo('File_Name.nc'); % replace File_Name with the name of NetCDF file for each wetlandscape. This
496 command gets the complete description for all the general attributes as well as detailed information of all existing
497 variables in the NetCDF file.

498 Var = ncread('File_Name.nc', 'Variable_Name'); % replace Variable_Name with the Variable Name column in Table
499 B2 for extracting different variable data from each wetlandscape NetCDF file.

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502 R Sample code:

503 install.packages("ncdf4")

504 library(ncdf4)

505 ncf <- nc_open("File_Name.nc ") # replace File_Name with the name of NetCDF file for each wetlandscape. This
506 command opens the NetCDF file in RStudio environment.

507 names(ncf\$var) # extracting the name of existing variables in the NetCDF file.

508 Var <- ncvar_get(ncf, " Variable_Name ") # replace Variable_Name with the Variable Name column in Table B2 for
509 extracting different variable data from each wetlandscape NetCDF file.