

Recommended Papers on Climate Change Impact and Its Adaptation

TITLE: An integrated approach to assess the vulnerability to erosion in mangroves using GIS models in a tropical coastal protected area

Authors: José Guilherme Moreira Simões Vieira, Joana Salgueiro, Amadeu Mortágua Velho da Maia Soares, Ulisses Azeiteiro, Fernando Morgado

<https://www.emerald.com/insight/content/doi/10.1108/IJCCSM-05-2017-0110/full/html>

ABSTRACT: The development of models that allows the evaluation and prediction of erosion processes is an important tool for the management and planning of coastal systems. Mangrove forests systems are under threat by the impacts of erosion, which is also intensified by human activity (and aggravated in the scenarios of global warming and climate change). The purpose of this paper is to develop a model of geographic information systems (GIS) that can be used for any estuary area, but it can also be used for mangroves. This paper uses georeferentiation which is defined as a set of parameters that best characterize the mangrove areas: elevation (m); geomorphology; geology; land cover; anthropogenic activities; distance to the coastline (m) and maximum tidal range (m). Three different methods are used to combine the various vulnerability parameters, namely, DRASTIC index, analytical hierarchy process (AHP) and square root of the geometric mean. The three approaches presented in this work show different types evaluating vulnerability to erosion, highlighting a stronger overvaluation of the areas presented with a high vulnerability, through the use of DRASTIC index when compared with two other approaches. The use of the AHP shows similarity to the square root of the geometric mean model, but the AHP also presents a higher percentage of vulnerable areas classified as having medium to very high vulnerability. On the other hand, the use of square root of the geometric mean led to a higher percentage of areas classified as having low and very low vulnerability.

1. TITLE: Perceptions of ecosystem services provision performance in the face of climate change among communities in Bobirwa sub-district, Botswana

Authors: Ephias Mugari, Hillary Masundire, Maitseo Bolaane, Mark New

<https://www.emerald.com/insight/content/doi/10.1108/IJCCSM-09-2017-0178/full/html>

ABSTRACT: Between 2006 and 2016, local communities in semi-arid Bobirwa sub-district in the Limpopo Basin part of Botswana had endured notable fluctuations in the delivery of critical ecosystem services. These changes have been coupled with adverse effects on local people's livelihood options and well-being. However, a few such studies have focussed on the semi-arid to arid landscapes. This study therefore aims to provide recent knowledge and evidence of consequences of environmental change on semi-arid arid landscapes and communities. To examine these recent changes in key ecosystem services, the authors conducted six participatory mapping processes, eight key informant interviews and several rapid scoping appraisals in three study villages. The analyses were centred on changes in seasonal quantities, seasonality, condition of ecosystem service sites, distance to ecosystem service sites and total area providing these services. Drivers of change in the delivery of key ecosystem services and the associated adverse impacts on human well-being of these recent changes in bundles of ecosystem services delivered were also analyzed. Results show that adverse weather conditions, drought frequency, changes in land-use and/or land-cover together with unsustainable harvesting because of human influx on local resources have intensified in the past decade. There was circumstantial evidence that these drivers have resulted in adverse changes in quantities and seasonality of key ecosystem services such as edible Mopane caterpillars, natural pastures, wild fruits and cultivated crops. Similarly, distance to, condition and total area of sites providing some of the key ecosystem services such as firewood and natural pastures changed adversely. These adverse changes in the key ecosystem services were shown to increasingly threaten local livelihoods and human well-being.

2. TITLE: Perceptions of climate change and water availability in the Mediterranean tourist sector: A case study of the Muga River basin (Girona, Spain)

Authors: Maria Torres-Bagur, Anna Ribas Palom, Josep Vila-Subirós

<https://www.emerald.com/insight/content/doi/10.1108/IJCCSM-10-2018-0070/full/html>

ABSTRACT: The purpose of this paper is understand these perceptions and identify main problems associated to climate change in order to design effective mitigation and adaptation strategies to guarantee the sustainability of tourism and natural resources. The Mediterranean basin is a leading international tourist destination and one that is particularly vulnerable to

the effects of climate change. Although these effects are largely known, in-depth studies of how they and the associated risks are perceived by key tourism stakeholders have not been performed. Interviews were held with 31 hotels, campsites and rural lodgings in the Muga River basin in north-east Catalonia, in which both owners and managers were asked about their perceptions of climate change, effects and countermeasures. Perceptions of climate change and its effects varied according to the type of establishment and location (coast, cities or inland). Significant differences were observed for perceptions of how responsibilities for implementing mitigation and adaptation measures to counter the effects of climate change, including water shortages, should be shared out between the main agents with an interest in guaranteeing the sustainability of tourism, namely, government bodies, tourist establishments and clients. The predominant opinion, however, was that the bulk of the responsibility should lie with government bodies



3. TITLE: Food security outcomes under a changing climate: Impacts of mitigation and adaptation on vulnerability to food insecurity

Authors: Katy J. Richardson, Kirsty H. Lewis, P. Krishna Krishnamurthy, Chris Kent, Andrew J. Wiltshire & Helen M. Hanlon

<https://link.springer.com/article/10.1007/s10584-018-2137-y>

ABSTRACT: Climate change is a potential threat to achieving food security, particularly in the most food insecure regions. However, interpreting climate change projections to better understand the potential impacts of a changing climate on food security outcomes is challenging. This paper addresses this challenge through presenting a framework that enables rapid country-level assessment of vulnerability to food insecurity under a range of climate change and adaptation investment scenarios. The results show that vulnerability to food insecurity is projected to increase under all emissions scenarios, and the geographic distribution of vulnerability is similar to that of the present-day; parts of sub-Saharan Africa and South Asia are most severely affected. High levels of adaptation act to off-set these increases; however, only the scenario with the highest level of mitigation combined with high levels of adaptation shows improvements in vulnerability compared to the present-day. The results highlight the dual requirement for mitigation and adaptation to avoid the worst impacts of climate change and to make gains in tackling food insecurity. The approach is an update to the existing Hunger and Climate Vulnerability Index methodology to enable future projections, and the framework presented allows rapid updates to the results as and when new information becomes available, such as updated country-level yield data or climate model output. This approach provides a framework for assessing policy-relevant human food security outcomes for use in long-term climate change and food security planning; the results have been made available on an interactive website for policymakers.



4. TITLE: Linking agricultural adaptation strategies, food security and vulnerability: evidence from West Africa

Authors: Sabine Douxchamps, Mark T. Van Wijk, Silvia Silvestri, Abdoulaye S. Moussa, Carlos Quiros, Ndèye Yacine B. Nour, Saaka Buah, Léopold Somé, Mario Herrero, Patricia Kristjanson, Mathieu Ouedraogo, Philip K. Thornton, Piet Van Asten, Robert Zougmore & Mariana C. Rufino

<https://link.springer.com/article/10.1007/s10113-015-0838-6>

ABSTRACT: Adaptation strategies to reduce smallholder farmers' vulnerability to climate variability and seasonality are needed given the frequency of extreme weather events predicted to increase during the next decades in sub-Saharan Africa, particularly in West Africa. We explored the linkages between selected agricultural adaptation strategies (crop diversity, soil and water conservation, trees on farm, small ruminants, improved crop varieties, fertilizers), food security, farm household characteristics and farm productivity in three contrasting agro-ecological sites in West Africa (Burkina Faso, Ghana and Senegal). Differences in land area per capita and land productivity largely explained the variation in food security across sites. Based on land size and market orientation, four household types were distinguished (subsistence, diversified, extensive, intensified), with contrasting levels of food security and agricultural adaptation strategies. Income increased steadily with land size, and both income and land productivity increased with degree of market orientation. The adoption of agricultural adaptation strategies was widespread, although the intensity of practice varied across household types. Adaptation strategies improve the food security status of some households, but not all. Some strategies had a significant positive impact on land productivity, while others reduced vulnerability resulting in a more stable cash flow throughout the year. Our results show that for different household types, different adaptation strategies may be 'climate-smart'. The typology developed in this study gives a good entry point to analyse which practices should be targeted to which type of smallholder farmers, and quantifies the effect of adaptation options on household food security. Subsequently, it will be crucial to empower farmers to access, test and modify these adaptation options, if they were to achieve higher levels of food security.



5. TITLE: The economic and food security implications of climate change in mali

Authors: T. A. Butt, B. A. McCarl, J. Angerer, P. T. Dyke & J. W. Stuth

<https://link.springer.com/article/10.1007/s10584-005-6014-0>

ABSTRACT: The study focuses on economic and food security implications of projected climate change on Malian agriculture sector. Climate change projections made by two global circulation models are considered. The analysis focuses on the effects on crops, forages, and livestock and the resultant effects on sectoral economics and risk of hunger in Mali. Results show that under climate change, crop yield changes are in the range of minus 17% to plus 6% at national level. Simultaneously, forage yields fall by 5 to 36% and livestock animal weights are reduced by 14 to 16%. The resultant economic losses range between 70 to \$142 million, with producers gaining, but consumers losing. The percentage of population found to be at risk of hunger rises from a current estimate of 34% to an after climate change level of 64% to 72%. A number of policy and land management strategies can be employed to mitigate the effects of climate change. In particular, we investigate the development of heat resistant cultivars, the adoption of existing improved cultivars, migration of cropping pattern, and expansion of cropland finding that they effectively reduce climate change impacts lowering the risk of hunger to as low as 28%.

6. TITLE: From climate-smart agriculture to climate-smart landscapes

Authors: Sara J Scherr, Seth Shames & Rachel Friedman

<https://link.springer.com/article/10.1186/2048-7010-1-12>

ABSTRACT: For agricultural systems to achieve climate-smart objectives, including improved food security and rural livelihoods as well as climate change adaptation and mitigation, they often need to be taken a landscape approach; they must become 'climate-smart landscapes. Climate-smart landscapes operate on the principles of integrated landscape management, while explicitly incorporating adaptation and mitigation into their management objectives. Results: An assessment of climate change dynamics related to agriculture suggests that three key features characterize a climate-smart landscape: climate-smart practices at the field and farm scale; diversity of land use across the landscape to provide resilience; and management of land use interactions at landscape scale to achieve social, economic and ecological impacts. To implement climate-smart agricultural landscapes with these features (that is, to successfully promote and sustain them over time, in the context of dynamic economic, social, ecological and climate conditions) requires several institutional mechanisms: multi-stakeholder planning, supportive landscape governance and resource tenure, spatially-targeted investment in the landscape that supports climate-smart objectives, and tracking change to determine if social and climate goals are being met at different scales. Examples of climate-smart landscape initiatives in Madagascar's Highlands, the African Sahel and Australian Wet Tropics illustrate the application of these elements in contrasting contexts. To achieve climate-smart landscape initiatives widely and at scale will require strengthened technical capacities, institutions and political support for multi-stakeholder planning, governance, spatial targeting of investments and multi-objective impact monitoring.

7. TITLE: Water management: Current and future challenges and research directions

Auhors: William J. Cosgrove Daniel P. Loucks

[https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1002/2014WR016869@10.1002/\(ISSN\)1944-9208.COMHES1](https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1002/2014WR016869@10.1002/(ISSN)1944-9208.COMHES1)

ABSTRACT: Water distinguishes our planet compared to all the others we know about. While the global supply of available freshwater is more than adequate to meet all current and foreseeable water demands, its spatial and temporal distributions are not. There are many regions where our freshwater resources are inadequate to meet domestic, economic development and environmental needs. In such regions, the lack of adequate clean water to meet human drinking water and sanitation needs is indeed a constraint on human health and productivity and hence on economic development as well as on the maintenance of a clean environment and healthy ecosystems. All of us involved in research must find ways to remove these constraints. We face multiple challenges in doing that, especially given a changing and uncertain future climate, and a rapidly growing population that is driving increased social and economic development, globalization, and urbanization. How best to meet these challenges requires research in all aspects of water management. Since 1965, the journal *Water Resources Research* has played an important role in reporting and disseminating current research related to managing the quantity and quality and cost of this resource. This paper identifies the issues facing water managers today and future research needed to better inform those who strive to create a more sustainable and desirable future.

8. TITLE: Understanding and managing the food-energy-water nexus – opportunities for water resources research

Authors: XimingCai, KevinWallington, MajidShafiee-Jood, Landon Marston

<https://www.sciencedirect.com/science/article/abs/pii/S0309170817304475>

ABSTRACT: Studies on the food, energy, and water (FEW) nexus lay a shared foundation for researchers, policy makers, practitioners, and stakeholders to understand and manage linked production, utilization, and security of FEW systems. The FEW nexus paradigm provides the water community specific channels to move forward in interdisciplinary research where integrated water resources management (IWRM) has fallen short. Here, we help water researchers identify, articulate, utilize, and extend our disciplinary strengths within the broader FEW communities, while informing scientists in the food and energy domains about our unique skillset. This paper explores the relevance of existing and ongoing scholarship within the water community, as well as current research needs, for understanding FEW processes and systems and implementing FEW solutions through innovations in technologies, infrastructures, and policies. Following the historical efforts in IWRM, hydrologists, water resources engineers, economists, and policy analysts are provided opportunities for interdisciplinary studies among themselves and in collaboration with energy and food communities, united by a common path to achieve sustainability development goals.

9. TITLE: State of the art for genetic algorithms and beyond in water resources planning and management

Authors: John Nicklow, Patrick Reed, Dragan Savic; Tibebe Dessalegne, Laura Harrell, Amy Chan-Hilton, Mohammad Karamouz, Barbara Minsker, Avi Ostfeld, Abhishek Singh, and Emily Zechman.

[https://ascelibrary.org/doi/abs/10.1061/\(ASCE\)WR.1943-5452.0000053](https://ascelibrary.org/doi/abs/10.1061/(ASCE)WR.1943-5452.0000053)

ABSTRACT: During the last two decades, the water resources planning and management profession has seen a dramatic increase in the development and application of various types of evolutionary algorithms (EAs). This observation is especially true for application of genetic algorithms, arguably the most popular of the several types of EAs. Generally speaking, EAs repeatedly prove to be flexible and powerful tools in solving an array of complex water resources problems. This paper provides a comprehensive review of state-of-the-art methods and their applications in the field of water resources planning and management. A primary goal in this ASCE Task Committee effort is to identify in an organized fashion some of the seminal contributions of EAs in the areas of water distribution systems, urban drainage and sewer systems, water supply and wastewater treatment, hydrologic and fluvial modeling, groundwater systems, and parameter identification. The paper also identifies major challenges and opportunities for the future, including a call to address larger-scale problems that are wrought with uncertainty and an expanded need for cross fertilization and collaboration among our field's subdisciplines. Evolutionary computation will continue to evolve in the future as we encounter increased problem complexities and uncertainty and as the societal pressure for more innovative and efficient solutions rises.

10. TITLE: Unsustainability Syndrome—From Meteorological to Agricultural Drought in Arid and Semi-Arid Regions

Authors:Ali Torabi Haghighi , Nizar Abou Zaki , Pekka M. Rossi , Roohollah Noori , Ali Akbar Hekmatzadeh , Hossein Saremi and Bjørn Kløve.

<https://www.mdpi.com/2073-4441/12/3/838>

ABSTRACT: Water is the most important resource for sustainable agriculture in arid and semi-arid regions, where agriculture is the mainstay for rural societies. By relating the water usage to renewable water resources, we define three stages from sustainable to unsustainable water resources: (1) sustainable, where water use is matched by renewable water capacity, ensuring sustainable water resources; (2) transitional, where water use occasionally exceeds renewable water capacity; and (3) unsustainable, with lack of water resources for agriculture, society, and the environment. Using available drought indicators (standardized precipitation index (SPI) and streamflow drought index (SDI)) and two new indices for agricultural drought (overall agricultural drought index (OADI) and agricultural drought index (ADI)), we evaluated these stages using the example of Fars province in southern Iran in the period 1977–2016. A hyper-arid climate prevailed for an average of 32% of the province's spatio-temporal coverage during the study period. The area increased significantly from 30.6% in the first decade (1977–1986) to 44.4% in the last (2006–2015). The spatiotemporal distribution of meteorological drought showed no significant negative trends in annual precipitation during 1977–2016, but the occurrence of hydrological droughts increased significantly in the period 1997–2016. The expansion of irrigated area, with more than 60% of rainfed agriculture replaced by irrigated agriculture (especially between 1997 and 2006), exerted substantial pressure on surface water and groundwater resources. Together, climate change, reduced river flow, and significant declines in groundwater level in major aquifers led to unsustainable use of water resources, a considerable reduction in irrigated area, and unsustainability in agricultural production in the period 2006–2015. Analysis of causes and effects of meteorological,

hydrological, and agricultural drought in the area identified three clear stages: before 1997 being sustainable, 1997–2006 being transitional, and after 2006 being unsustainable.

11. TITLE: Revisiting Telemetry in Pakistan's Indus Basin Irrigation System

Authors: Muhammad Tousif Bhatti, Arif A. Anwar and Muhammad Azeem Ali Shah

<https://www.mdpi.com/2073-4441/11/11/2315>

ABSTRACT: The Indus Basin Irrigation System (IBIS) lacks a system for measuring canal inflows, storages, and outflows that is trusted by all parties, transparent, and accessible. An earlier attempt for telemetering flows in the IBIS did not deliver. There is now renewed interest in revisiting telemetry in Pakistan's IBIS at both national and provincial scales. These investments are typically approached with an emphasis on hardware procurement contracts. This paper describes the experience from field installations of flow measurement instruments and communication technology to make the case that canal flows can be measured at high frequency and displayed remotely to the stakeholders with minimal loss of data and lag time between measurement and display. The authors advocate rolling out the telemetry system across IBIS as a data as a service (DaaS) contract rather than as a hardware procurement contract. This research addresses a key issue of how such a DaaS contract can assure data quality, which is often a concern with such contracts. The research findings inform future telemetry investment decisions in large-scale irrigation systems, particularly the IBIS.

12. TITLE: Increasing compound events of extreme hot and dry days during growing seasons of wheat and maize in China

Authors: You Lu, Hongchang Hu, Chao Li & Fuqiang Tian

<https://www.nature.com/articles/s41598-018-34215-y>

ABSTRACT: Compound events of climate extremes such as extremely high temperature and low precipitation during crop growing seasons can greatly affect agricultural production and food security. No study has investigated how Compound Extreme Hot and Dry days (CEHD days) during crop-growing seasons have changed or will change in response to climate warming. Based on observations, we find upward trends in CEHD days during wheat and maize growing seasons in China in the historical period 1980–2015. These trends are remarkably different during wheat and maize growing seasons, pointing to the need for targeted analysis focusing on crop-specific growing seasons. Projections of future temperature and precipitation from the Coordinated Regional Climate Downscaling Experiment show that upward trends will continue into future. On average over China, the frequencies of CEHD days during wheat and maize growing seasons are projected to increase respectively by 168% and 162% in 2036–2050 relatively to 1980–2015 under the RCP8.5 emissions scenario. The projected increases may have serious implications for China's food production, adding to the need for resilience planning to limit the impacts of growing season CEHD days.

13. TITLE: Projected climate change impacts on future streamflow of the Yarlung Tsangpo Brahmaputra River

Authors: Ran Xua, Hongchang Hua, Fuqiang Tiana, Chao Li, Mohd Yawar Ali Khan

<https://www.sciencedirect.com/science/article/pii/S092181811830506X>

ABSTRACT: The Yarlung Tsangpo-Brahmaputra River (YBR) originating from the Tibetan Plateau (TP), is an important water source for many domestic and agricultural practices in countries including China, India, Bhutan and Bangladesh. To date, only a few studies have investigated the impacts of climate change on water resources in this river basin with dispersed results. In this study, we provide a comprehensive and updated assessment of the impacts of climate change on YBR streamflow by integrating a physically based hydrological model, regional climate integrations from CORDEX (Coordinated Regional Climate Downscaling Experiment), different bias correction methods, and Bayesian model averaging method. We find that (i) bias correction is able to reduce systematic biases in regional climate integrations and thus benefits hydrological projections over YBR Basin; (ii) Bayesian model averaging, which optimally combines individual hydrological simulations obtained from different bias correction methods, tends to provide hydrological time series superior over individual ones. We show that by the year 2035, the annual mean streamflow is projected to change respectively by 6.8%, -0.4%, and -4.1% under RCP4.5 relative to the historical period (1980–2001) at the Bahadurabad in Bangladesh, the upper Brahmaputra outlet, and Nuxia in China. Under RCP8.5, these percentage changes will substantially increase to 12.9%, 13.1%, and 19.9%. Therefore, the change rate of streamflow shows strong spatial variability along the YBR from downstream to upstream. The increasing rate of streamflow shows an augmented trend from downstream to upstream under RCP8.5 compared to an attenuated pattern under RCP4.5.

14. TITLE: Assessment of Climate Change Impacts on Reference Evapotranspiration and Simulation of Daily Weather Data Using SIMETAW

Authors: Meisam Ebrahimpour; Nozar Ghahreman; and Morteza Orang

[https://ascelibrary.org/doi/abs/10.1061/\(ASCE\)IR.1943-4774.0000669](https://ascelibrary.org/doi/abs/10.1061/(ASCE)IR.1943-4774.0000669)

ABSTRACT: In this study, a SIMulation of EvapoTranspiration of Applied Water (SIMETAW) model was evaluated using monthly climatic data of four stations in Iran, namely Bushehr, Tabriz, Zahedan, and Mashhad, to investigate the effects of climate change on reference evapotranspiration (ET_o). SIMETAW generates daily weather data from monthly values applicable in climate change studies. HadCM3 (Hadley Centre Coupled Model ver.3) outputs were statistically downscaled to project future variables. Maximum, minimum, and dew point temperature, precipitation, and wind speed were downscaled under two emission scenarios (A2 and B2) and two future periods (2020–2050 and 2050–2080) to simulate ET_o. Calculated ET_o values were compared with those simulated by SIMETAW in the base period (1961–2000). Results showed that, except for daily wind speed, the model accurately generated daily temperature variables and monthly precipitation. Furthermore, ET_o is expected to increase in most months. Values of ET_o at Bushehr Station are projected to increase from 164.7 to 181.2 mm=month in 2050–2080, under the B2 scenario. The corresponding values are 125.4 to 137.5, 182.7 to 197.5, and 118.3 to 128.8 mm=month for Tabriz, Zahedan, and Mashhad, respectively.

15. TITLE: Comparison of three multi-site models in stochastic reconstruction of winter daily rainfall over Iran

Authors: Mahdi Ghamghami, · Nozar Ghahreman, · Hossein Olya, · Tahereh Ghasdi

<https://link.springer.com/article/10.1007/s40808-019-00599-7>

ABSTRACT: Spatiotemporal modeling of daily rainfall may establish the spatial relationships between different stations which is an important issue in hydro-climatology and has been addressed by various studies. The aim of this study is to compare three multi-site models, i.e. hidden Markov model (HMM), non-homogeneous hidden Markov model (NHMM), and K-nearest neighbor model (KNN) in stochastic generation of rainfall data over a network consisting of 130 synoptic stations across Iran using 20-year (1991–2010) daily dataset. Regarding the NHMM, the hidden layer parameters were considered time dependent, such that a layer including predictors was added to HMM. General circulation model (GCM) outputs could be selected as the elements of this layer or predictors. A principle component analysis (PCA) was implemented on four standardized variables of HADGEM2 model (pressure, geo-potential height, temperature, and specific humidity) for historical period on 29 grids across Iran. Accordingly, pressure variable has been selected as a predictor layer in the NHMM according to Bayesian Information criteria (BIC). Results showed that the NHMM has a significant lower BIC compared to the HMM, which confirms the time-dependence assumption of Markov transition probabilities. In stochastic generation process by NHMM and KNN models, different criteria such as seasonal mean and variance, empirical distribution of daily precipitation data in winter, probabilities of wet and dry spells in various sequences and spatial dependency have been compared. According to the results, the NHMM had a significantly better performance compared to KNN model. Nevertheless, no model was able to precisely generate rainfall based on all the evaluation criteria. Log-odds ratio as the spatial correlation criterion illustrated that both NHMM and KNN have promising results in reconstructing spatial relationships. Therefore, both models could be considered as multi-site approaches with a good skill in keeping spatiotemporally changing parameters. The findings of this study may improve the seasonal predictability of rainfall characteristics across the country.

