

The Role of Higher Education in Managing the Impacts of Climate Change, With a Focus on the Kurdistan Region, Iraq

Serwan Baban, The Presidency of Kurdistan Region, Iraq

The European Conference on Education 2025
Official Conference Proceedings

Abstract

The Kurdistan Region of Iraq is experiencing the impacts of climate change on its water resources, agriculture, human health, and natural environment. Higher education institutions (HEIs) must respond and fulfill their vital role in managing climate change's root causes and impacts in various sectors. The ultimate goal will be to develop and integrate climate education, training, research, and innovation to educate and empower dedicated professionals on the science of climate change and its policy, economic, and social dimensions. This paper outlines the impacts of climate change in the Kurdistan Region of Iraq. To enhance the role of higher education in this context, it advocates for introducing key concepts of sustainable development and climate change perspectives into HEIs' teaching and training programs. Additionally, it aims to advance HEIs' research interests by creating science-based, data-driven, and innovative solutions to effectively address the impacts of climate change on people's lives, the economy, and the environment. The paper also identifies essential elements that should be integrated into education, training, and research efforts in KRI higher education institutions. Finally, it presents several relevant, scientifically sound research outcomes that can serve as case studies, aimed at providing practical local solutions and advancing sustainable practices for managing challenges associated with water resource management, smart agriculture, early warning systems, and mapping natural hazards linked to climate change.

Keywords: higher education, climate change, management, sustainability, Kurdistan region of Iraq

iafor

The International Academic Forum
www.iafor.org

Introduction

The Earth's climate is changing rapidly, primarily due to the emissions from fossil fuels, particularly carbon dioxide, which traps heat in the Earth's atmosphere. This change is largely driven by anthropogenic activities related to industrialization and land use, both of which are influenced by population growth and consumerism (Baban, 2004a, 2004b; IPCC, 2001).

Climate change (CC) is urgent and time-sensitive. Therefore, radical and immediate actions must be taken by the government and society before reaching the “tipping point,” beyond which the impacts of climate change become rapid and irreversible (IPCC 2018; McCowan, 2020). More recently, the IPCC in its 6th Assessment Report advised that “unless there are immediate, rapid and large-scale reductions in greenhouse gas emissions, limiting warming to close to 1.5°C or even 2°C will be beyond reach” (Lehtonen et al., 2019).

Higher Education Institutions (HEIs) represent key centres for teaching, learning, training, and research. They can play a critical role in understanding and managing climate change crises through their education, training, and research activities. Hence, they are important players in the formation of professionals, of services provided to communities and government, and are micro-societies and economies in their own right (Filho et al., 2023; McCowan, 2020).

This paper outlines the impacts of climate change in the Kurdistan Region of Iraq. To enhance the role of higher education in this context, it advocates for introducing key concepts of sustainable development and climate change perspectives into climate change education, training, and research (CCETR) programs at higher education institutions (HEIs). Additionally, it aims to advance the research interests of HEIs to develop science-based, data-driven, and innovative solutions that effectively address the impacts of climate change on people's lives, the economy, and the environment. The paper also identifies essential elements that should be integrated into education, training, and research efforts in higher education institutions in the Kurdistan Region of Iraq (KRI). Finally, it presents several relevant, scientifically sound research outcomes that can serve as case studies, providing practical solutions and advancing sustainable practices for managing challenges associated with water resource management, smart agriculture, early warning systems, and mapping natural hazards linked to climate change.

Higher Education Institutions and Climate Change

Higher Education Institutions' (HEIs) have a vital role in ensuring a sustainable future. HEIs relevance lies in their ability to apply theoretical knowledge to practical questions of mitigation and adaptation. This includes understanding the specific causes and impacts of climate change in identified locations, initiating and leading research, developing renewable energy technologies, and promoting sustainability through campus initiatives. HEIs are also expected to lead and contribute to public debate by disseminating the scientific “facts” about climate and by provoking reflection on the profound economic and political shifts required to address it (Filho et al., 2023; McCowan, 2020; Nosir, 2023).

Climate change education, training, and research (CCETR) must be grounded in a scientific understanding of socio-ecological systems and the ethical dimensions of human behaviour. Additionally, it should aim to foster the development of societies that are flexible, adaptable,

well-informed, innovative, and dedicated to sustainability and human well-being (Lehtonen et al., 2019).

Given the circumstances, the increasing demands to address climate change impacts present real opportunities for higher education institutions (HEIs) in the KRI and beyond to play a crucial role in the global effort to combat climate change by addressing its root causes.

The literature shows that some work has been conducted by HEIs on the climate itself and some of the Sustainable Development Goals (SDGs). Also, some other works have focused primarily on greening campuses (Atherton & Giurco, 2011; Benayas et al., 2010) and incorporating selected issues into the curriculum (Fahey, 2012; Filho, 2010; Molthan-Hill et al., 2019; Vaughter et al., 2013). Generally speaking, HEIs have yet to fulfil their fundamental role and articulate their contribution to managing climate change challenges (Hansen & Lehmann, 2006; McCowan, 2020).

A Methodology to Enhance and Guide KRI Higher Education Contributions to Managing the Impacts of Climate Change

HEIs hold a great potential to address complex problems, enabling students, researchers, and practitioners in the field to respond to climate change impacts and prevent future disasters.

This aspiration can be realized through HEIs using their capabilities to (McKeown and Hopkins, 2010; McCowan, 2020; Nosir, 2023; Stevenson et. al., 2017):

- i. Develop a climate-resilient workforce by enabling students to become informed about climate science, acquire the necessary skills for the green economy, and cultivate attitudes and behaviors needed to engage effectively with climate solutions. Creating a sustainable future starts with educating and informing individuals that by cultivating a reverence for nature and a sense of responsibility to care for it, attitudes and habits foster sustainable behaviors that balance environmental, social, and economic needs so that all can prosper.
- ii. Build capacities to promote sustainable development necessitates focusing the curriculum and a system-wide commitment on local and regional levels.
- iii. Promote the necessary research and innovation to sustainably manage the impacts of climate change and to learn to manage risk, learn to live and function with risk, uncertainty, and rapid change.

Energizing the role of KRI Higher Education Institutions to develop an effective climate change education, training, and research (CCETR) needs to include the three main sections:

An Overview of the Climate Change Issues in the KRI

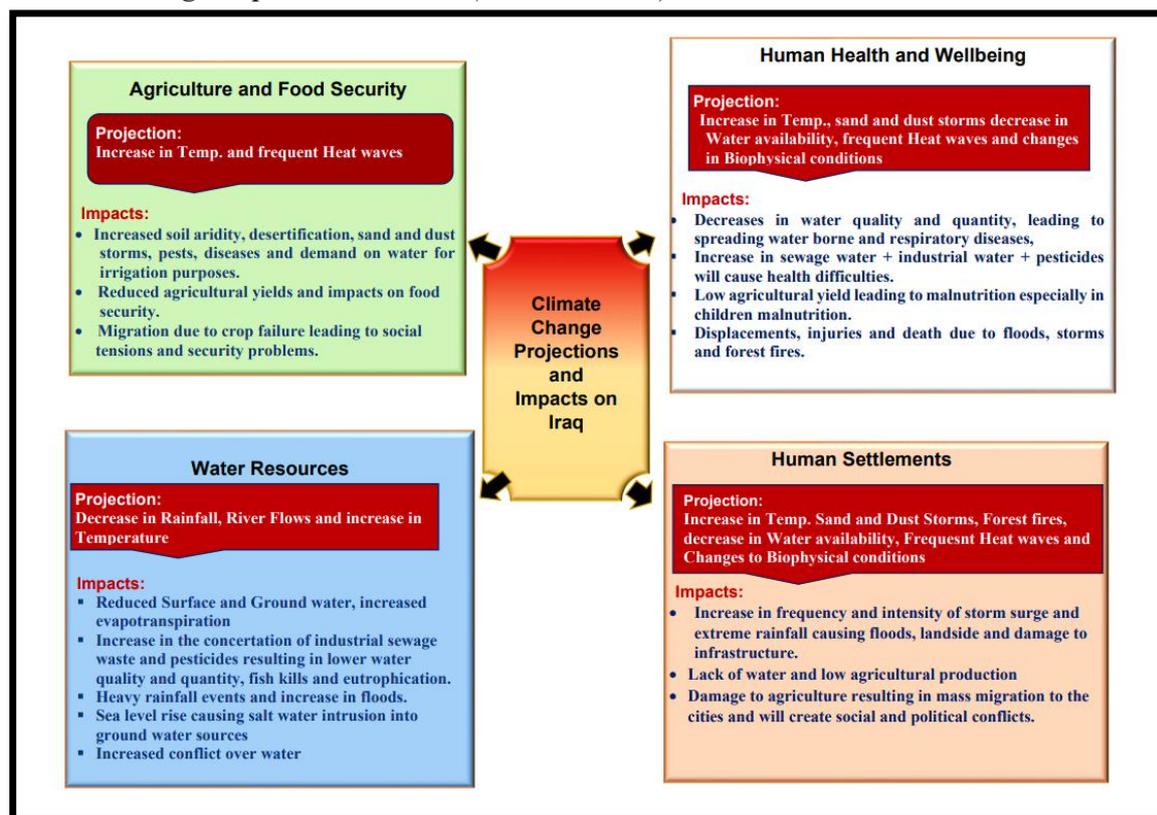
The KRI is currently facing several challenges associated with this phenomenon (Figure 1). These include the rapid expansion of the desertification process, frequent and intense dust storms, prolonged drought conditions, and heat waves, with temperatures frequently rising above 50°C (Figure 1) (Baban, 2024a; Janabi, 2013; Lelieveld et al., 2012). Consequently, this trend presents a challenge for agriculture, as FAO scientists believe that an increase of 1% in average temperature results in a 10% loss in agricultural productivity. Furthermore, as temperatures climb and evaporation increases, the demand for water rises, particularly among farmers who need to modernise their irrigation methods. Another problem associated with climate change is a shift in precipitation patterns. Rain used to fall with less intensity over

longer periods. However, of late, there has been less snow, and rainfall is more intense, preventing the land from absorbing rainwater and replenishing groundwater, while increasing flow and potentially causing erosion, landslides, and floods (Baban, 2024b; Hama et al., 2014). The expected changes in climate will affect society and have serious impacts on the economy, agriculture, health, and the environment (Baban, 2024a).

In the KRI, the current capacity for adaptation, mitigation, and resilience to climate change in various sectors, including natural resources, agriculture, health, and environment, is reactive, fragmented, marginal, and reliant on hard engineering approaches. The provisions are mainly focused on short-term relief, such as post-event compensation, repairing damaged infrastructure, and clean-up operations. Furthermore, they are also based on methods that estimate the economic impact of an event and not the necessary social, ecological, and environmental impacts. Hence, there is a pressing need for HEIs to develop a national capacity for, and to factor in the unavoidable consequences of climate change on the environment, economy, and society (Baban, 2024b). However, information poverty concerning climate change management through adaptation, mitigation, and resilience is a tangible challenge.

Figure 1

Climate Change Impacts in the KRI (Baban, 2024a)



At present, there is an absence of a national data depository for climate change-related events, where event occurrences can be recorded and quantified for post-analysis. The limited resource base, coupled with demands to prioritize responses to climate change consequences, necessitates enhancing the role of Higher Education to educate, inform, and develop science-based and data-driven solutions (Baban, 2024b).

Identifying and Engaging Relevant Concepts and Themes

Identifying relevant key concepts' themes and integrating them into HEIs' programs in climate change education, training, and research is a necessary step to start the process.

An obvious concept for advancing Climate Change Education, Training, and Research (CCETR) is sustainability. This is due to its holistic nature, encompassing key competencies such as systems thinking, strategic thinking, collaboration, critical thinking, self-awareness, and integrated problem-solving (Nosir, 2023; Rieckmann, 2018). Furthermore, sustainability pedagogies are typically place or issue-based and focus on improving local communities (Lelieveld et al., 2016). Such experiences not only develop students' knowledge and skills but also their disposition to make reasoned decisions and consider alternative, more sustainable ways of living (Nosir, 2023). Sustainability also serves as an optimal framework for advancing CCETR, as it can integrate the economic, social, and environmental dimensions of sustainability into the curriculum (Hedefalk et al., 2015), underscoring the interconnected nature of human development, well-being, equity, and environmental stewardship (Mochizuki & Bryan, 2015; Nosir, 2023).

The second concept is Climate change science and education (CCSE), which represents the intersection of disciplines like geography, meteorology, biology, physics, earth sciences, and chemistry. CCSE also includes effective communication skills about climate and climate change, attitudes, motivations, and beliefs needed to make informed and responsible decisions (Azevedo & Marques, 2017).

In terms of course and curriculum design, these should be restructured so that all subjects, from mathematics to literature, incorporate sustainability and climate change perspectives. For example, an economics course could explore circular economy models, while a design course could focus on sustainable architectural solutions (Filho et al., 2023).

Identifying and Integrating the Relevant Elements Into Education, Training and Research Programmes

Climate change education, training, and research (CCETR), by nature, encompasses all of the disciplinary areas, from natural sciences to social sciences and arts and humanities, in academic and professional courses. Also, in terms of research, it is endeavours to combat climate change and framing possible solutions, reflecting on the roots of the problem, including human nature interdependency (Lehtonen et al., 2019).

CCETR teaching and training will need to be grounded in sustainability and student-led inquiry as approaches for developing students' abilities to think, act, and reflect as local and global citizens striving to create a more sustainable world (Nosir, 2023).

The development and implementation approaches should view teaching, training, and research requirements through the lenses of climate change causes, impacts, mitigation, and adaptation. In addition to adopting innovative, problem-based methods that develop students' critical and creative thinking skills, as well as their ability to solve real-world problems. Finally, relevant case studies should be included and used to illuminate and disclose the causes, effects, and possible solutions (Nosir, 2023).

Education

Climate Change Education must be a cross-cutting component that permeates all aspects of university life. From the natural sciences to the humanities, Climate Change Education presents a blend of science, engineering, and socio-economic issues that can manage science-based concerns, such as natural causes and changes in the climate system, and address climate justice, including how groups like women and girls and indigenous peoples are differentially impacted. All disciplines have a role to play in educating responsible citizens and professionals committed to nature.

Climate change education should aim to develop students' knowledge, skills, and experiences on climate science, disaster risk reduction, environmental change, and solutions and action. In addition to the following key competences (Eilam & Widdop, 2019; Filho et al., 2023; Kwauk, 2021; Nosir, 2023; Sheppard, 2012; UNESCO, 2016, 2021):

- i. Developing a curriculum that encompasses climate science, ecosystems and biodiversity, climate justice, resilience building, post-carbon economies, and sustainable lifestyles.
- ii. Developing specialized themes with the curriculum that have a focus on sustainable agriculture, water management, and advanced farming technologies suitable for arid environments.
- iii. Promoting Systems thinking to facilitate understanding the interrelationships between natural, social, and economic systems.
- iv. Fostering foresight and planning to enable anticipating future scenarios and designing sustainable policies.
- v. Nurturing collaboration and problem solving to facilitate working in multidisciplinary teams to solve climate problems.
- vi. Embedding Ethical and global responsibility to instigate making conscious decisions that take into account the well-being of the planet and future generations.
- vii. Developing creativity and innovation to enable designing transformative solutions that advance sustainability.

Outreach and Training

HE, through their outreach and training, will need to develop programs to help the general public understand and address climate change's impacts. By raising awareness of the problem and supporting capacity and capability building, they can promote and encourage changes in attitudes and behaviours, focusing on adaptive change in preparing people to face the challenges of a changing climate.

HE can also directly engage in climate change outreach and training through discipline-led activities, interdisciplinary efforts, and collaborative work with local, national, and international stakeholders and partners (Filho et al., 2021a, 2021b; Filho et al., 2022; Filho et al., 2023).

More specifically, HEIs' outreach and training are required to:

- Provide Hands-on Training: Offering practical experience in smart and modern agricultural techniques, including hydroponics, vertical farming, and precision agriculture.
- Raise Awareness: Educating the public about the importance of sustainability, water and food security, and managing excessive consumption practices.

- Work with the media to shape perceptions and minimize the spread of climate change misinformation and disinformation, so that the public develops critical literacy skills to discern truth from falsehoods.

Research and Innovation

HEIs, through their research and innovation work, will need to focus their efforts on observed changes in climate, drivers of climate change, future climate change, risks and impacts, adaptation and mitigation strategies, socio-economic factors, policy and governance issues, and ethical considerations.

In terms of Research and Innovation programs, KRI HEIs will need to develop programs with a specific emphasis on (Holloway & Fortune, 2018; Kitagawa, 2017; McCowan, 2020; Preston et al., 2015):

1. Mitigation tools and actions to lessen the direct impact of climate change through reducing greenhouse gas emissions, investments in fossil fuel Companies, concerning fuel efficiency, carbon capture, etc., and changing the mindsets of society to encourage climate-friendly actions in daily lives.
2. Adaptation activities and tools to introduce adjustments to natural and human systems in response to the actual or expected climatic stimuli or their effects, which moderate harm or exploit beneficial opportunities.
3. Preparedness and resilience, which will involve application of knowledge to address required changes in lifestyles, agriculture, housing, healthcare, and so forth, both about capacity building and awareness raising, but also generation of new ideas and technologies.

More specifically, for the KRI, the author, through his involvement as a senior scientist, member of the high council for the environment in the KRI, and an active participant representing KRI Presidency in both COP27 and COP28, as the author for KRI COP29 regional priorities, identified the following as research priorities and conditions for:

i. Food Systems

Climate-smart agricultural technologies and practices such as land and water resources conservation, Drought Resistant Crops, precision and smart agriculture, agroecology, water-efficient irrigation, modern farming such as hydroponic renewable energy and energy efficiency, climate adapted crop types/varieties and livestock types/breeds, crop/livestock diversification, agro-forestry, integrated pest and disease management, post-harvest technologies, improved livestock management, fodder production and livestock feeding strategies.

ii. Water Resources Management

The adaptation actions focused on the water-agriculture-poverty nexus are critical for the KRI. Accordingly, there is a need for research and innovation to:

- Improve regional cooperation and at the national level to enhance water use efficiency and productivity jointly with demand management policies, and improve water allocation and appropriate valuation.
- Support the use of the best available hydro-climatic information to improve water resources management

- Promote sustainable utilization of groundwater and use of modern technologies in monitoring and controlling groundwater aquifers
- Develop water harvesting schemes.
- Modernize irrigation and drainage systems, manage salinity, and rehabilitate and update the operation of dams
- Repurpose public sector support and policies (including subsidies) toward sustainable outcomes in the water and agricultural sectors, and encourage investments in the agri-food sector
- Support the management of extreme events (integrated flood management, drought management).

iii. Renewables

The KRI will need to reassess its production and consumption of fossil fuels, examine possible mitigation and adaptation measures, and initiate a significant shift to renewable, clean energy sources.

iv. Management Instruments

The KRI will need to develop the necessary instruments for climate change management, including efforts to;

- Develop early warning systems and predictive understanding of landslide and flood processes and triggering mechanisms.
- Make Data Validation and Metadata development an essential part of all the outcomes from consultancies and research projects funded by the government.
- Coordinate the efforts amongst various relevant ministries and agencies concerned with climate change-related events.
- Develop effective programs for public awareness, education, and information diffusion.
- Adopt a public education drive in schools and through the media to inform the public of “incorrect” practices, amplifying climate change-related hazards and the consequences for the community and the country.
- Examine and develop effective Insurance mechanisms as an instrument for managing geohazards and loss reduction measures.

v. Management Scenarios

The KRI will need to develop plausible management scenarios to account for the effects of climate change on the economy and society.

vi. Seeking International Collaboration

The KRI will need to be tempting to persuade international funding agencies to fund quality research and capacity building in the KRI, specifically by providing up-to-date satellite imagery and developing management scenarios to account for the effects of climate change on the economy and society. In addition to identifying and supporting the most vulnerable groups and people in society.

Practical Solutions as Case Studies

Teaching and learning regarding climate change can best be implemented through relevant case studies that can illuminate causes, effects, and solutions as pedagogical tools (Nosir, 2023).

The following presents several relevant and published research outcomes that can serve as case studies aimed at presenting practical solutions and advancing sustainable practices for managing climate change challenges associated challenges in the KRI.

Smart Agriculture: Strategic Agricultural Production

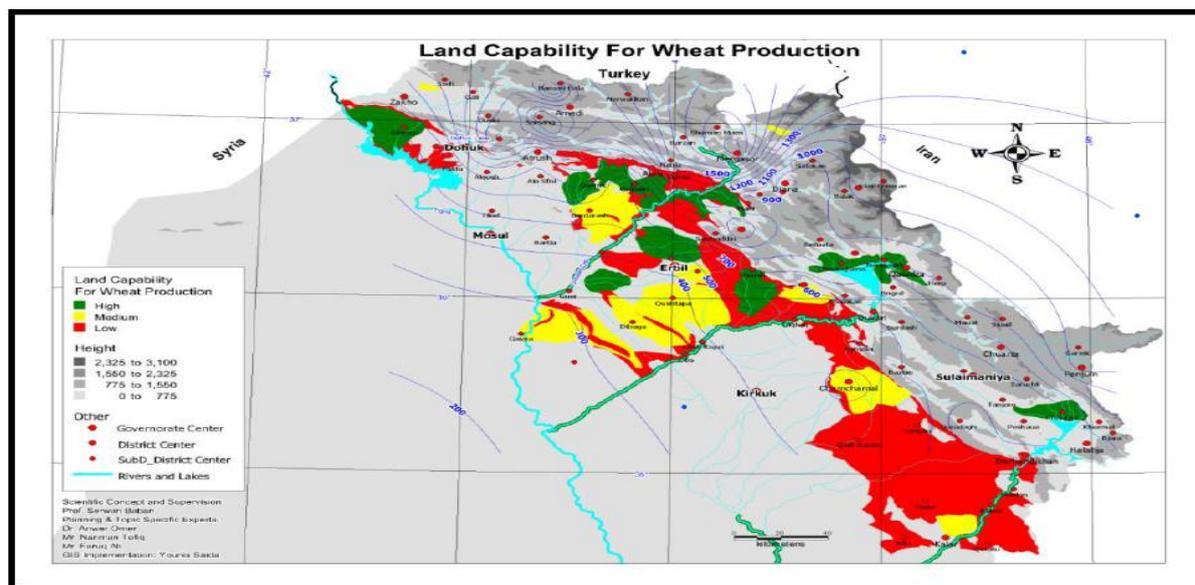
During 2016, Baban identified the major parameters that affect productivity in the KRI. These included: nutrition represented by soil types and climatic needs represented by rainfall and temperature. Then, a GIS-based approach was developed to create the necessary datasets and to develop specific agro-climatic zone maps for growing 16 strategic crops in the KRI (Table 1). These included a map locating the most suitable locations for producing Wheat in the KRI (Figure 2) (Baban, 2016).

Table 1

The Parameters Affecting the Productivity of 16 Strategic Products in the KRI (Baban, 2016)

No	Production	Soil Type (Reconnaissance Soil Legend)	Temperatures (Centigrade)			CWR (mm)
			Min.	Max.	Optimal	
1	Wheat	Loam-Sand-Clay	5	38	20-25	350
2	Barley	Loam-Sand-Clay	5	38	20-25	250
3	Corn	Loam	20	32-34	22-25	817.41
4	Tomato	Loam	12	28-34	15-20	758.3
5	Potato	Loam	12	28-34	15-20	875.13
6	Sunflower	Sand-Clay	20	25	25	837.37
7	Apple	Clay- Loam	-5	32	30	567.53
8	Courgette	Loam	15	45	25-30	400.41
9	Grape	Clay-Loam-Sand	0	35	5-25	567.53
10	Peach	Sand-Loam	15	45	25-30	567.53
11	Cucumber	Loam-Sand-Clay	25	30	25-30	400.41
12	Pomegranate	Clay-Loam-Sand	15	45	25-30	567.53
13	Rice	Clay	18-22	37-40	30-33	1408
14	Soybean	Sand-Clay	10-14	37-40	25-28	959.75
15	Onion	Sand	15	45	25-30	400.41
16	Eggplant	Sand-Clay	16	45	25-30	400.41

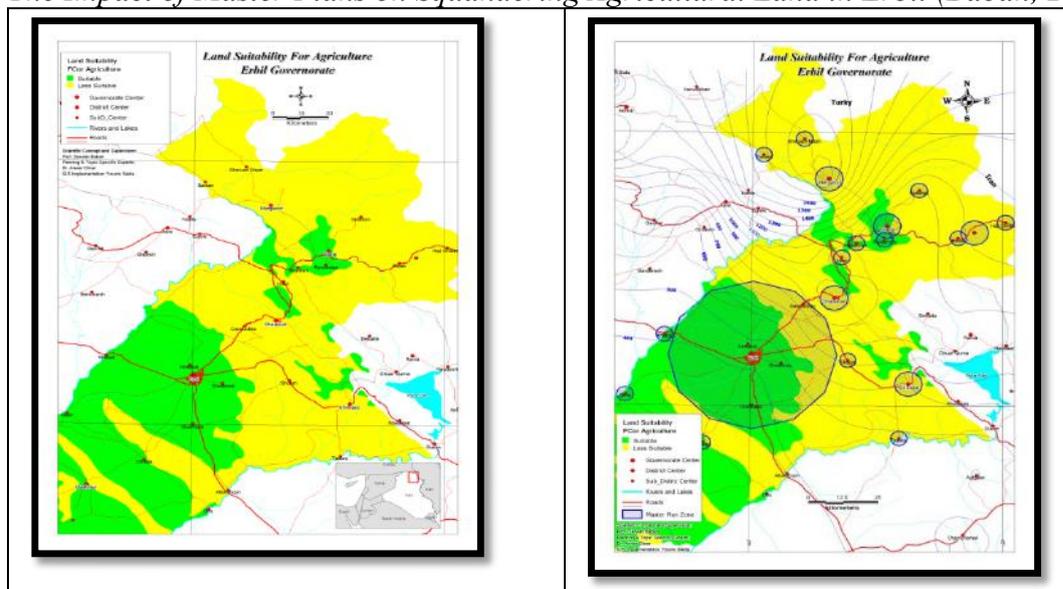
Figure 2
Most Suitable Locations for Wheat Production in the KRI (Baban, 2016)



Nature-Based Solutions: Saving Prime Agricultural Land

Baban, during 2015, researched the Impact of Master Plans on Squandering Agricultural Land in the KRI. In this study, he identified suitable land for agriculture based on climate, slope and soil depth (determining rooting volume and water storage), and texture of soil (determining water availability and land drainage) Figure 3). Then, the proposed boundaries for the KRI master plans were overlaid on the map to determine, under current practice (Figure 3), the impacts of urban expansion on wasting prime agricultural land within the KRI. The results showed a significant estimated loss in all the governorates, and the overall loss is about 27% of the prime land for agriculture in the KRI (Baban, 2015).

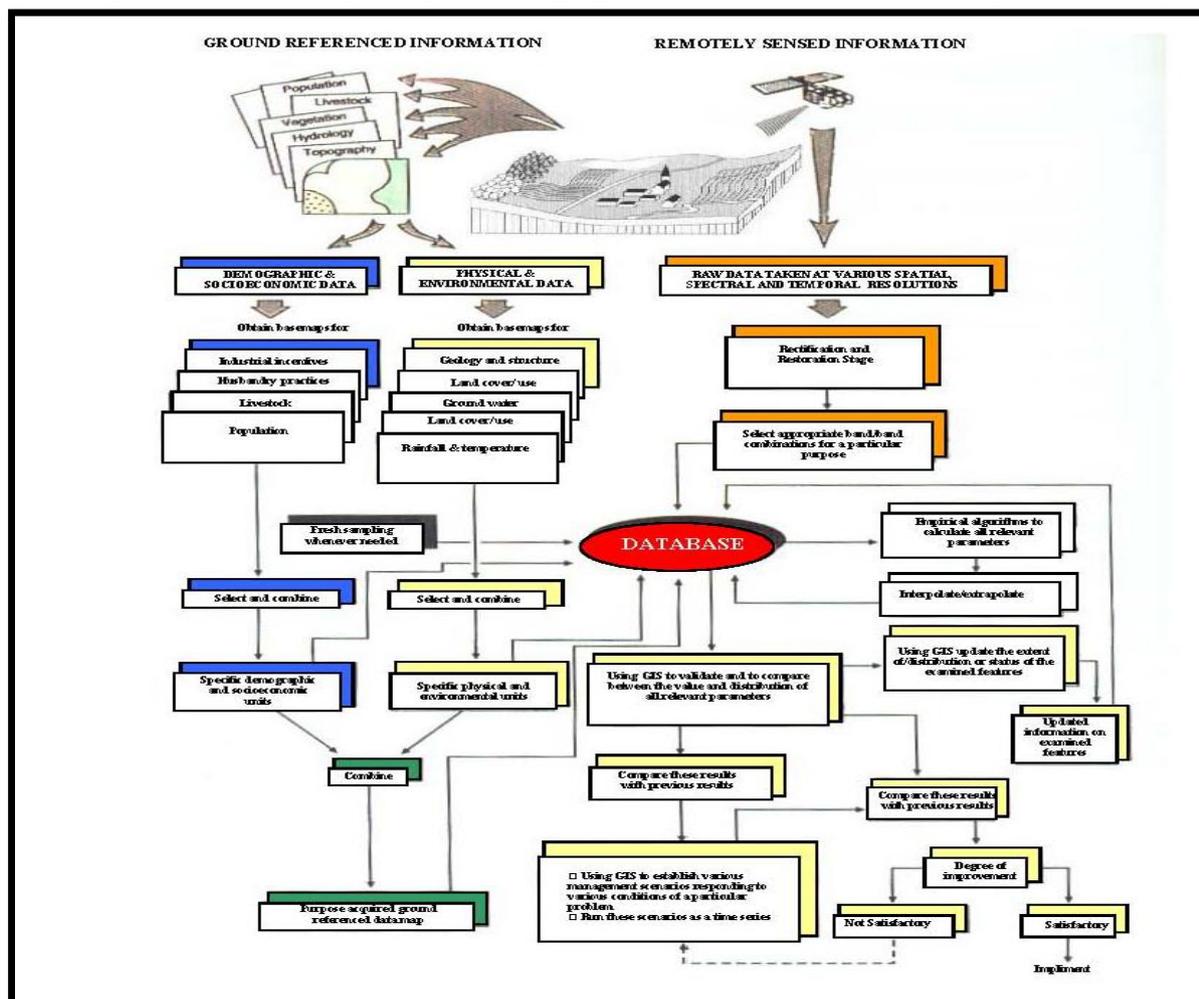
Figure 3
The Impact of Master Plans on Squandering Agricultural Land in Erbil (Baban, 2015)



Water Resources Management: Managing Water Resources in the KRG

Baban, during 2006, developed a Geoinformatics-based system for managing water resources in the KRI (Figure 4). The proposed system has a geo-based holistic approach that can be updated as required. Furthermore, through the GIS component, the system allows for examining the suitability of various management options, and identifying the best option to effectively manage these resources under specific conditions (Baban, 2006).

Figure 4
A Geoinformatics-Based System for Managing Water Resources in the KRI. (Baban, 2006)



Conclusions

Climate change is an urgent challenge facing humanity and the future of the planet. KRI higher education is presently encountering the impacts of climate change, which are manifesting as increasing temperatures, reduced precipitation levels, changes in distribution patterns, degradation of arable land due to desertification, frequent droughts and sandstorms, and a decrease in agricultural productivity. These factors are likely to result in increased hardship for the populace and heightened social instability in the years to come, if appropriate protective planning and solutions are not implemented.

This work indicated that a way forward is through the KRI, higher education helping to build a sustainable and climate-resilient future. This ambition can be realized through using the lens of climate change to develop educational and training programs to upskill current and future leaders and professionals to introduce and manage the much-needed systemic change and transformations. Also, through research and innovation to build local knowledge and create science-based, data-driven, and innovative solutions to effectively handle the impacts of climate change on various sectors, and regions with the view to developing adaptation scenarios, planning for the human and economic costs, and strengthening government policies for mitigation, crisis avoidance, and protection of the vulnerable population.

The paper also identified the essential elements that should be integrated into education, training, and research efforts in KRI higher education institutions. It also presented several relevant research outcomes that can serve as case studies, aimed at providing practical local solutions and advancing sustainable practices for managing challenges associated with smart agriculture and water resource management in the KRI.

References

- Atherton, A., & Giurco, D. (2011). Campus sustainability: Climate change, transport, and paper reduction. *International Journal of Sustainability in Higher Education*, 12(3), 269–279. <https://doi.org/10.1108/14676371111148054>
- Azevedo, J., & Marques, M. (2017). Climate literacy: A systematic review and model integration. *International Journal of Global Warming*, 12(3/4), 414–430. <https://doi.org/10.1504/IJGW.2017.084789>
- Baban, S. M. J. (2003). Responding to the Effects of Climate Change on Agriculture, Fisheries and Tourism in the Caribbean Region Utilising Geoinformatics. *Journal of Farm and Business*, 4(1), 95–111. <https://doi.org/10.22004/ag.econ.45795>
- Baban, S. M. J. (2006). Developing a Geoinformatics-Based Approach to Manage Water Resources in Southern Kurdistan. *International Journal of ZANIN*, 2(1), 27–45.
- Baban, S. M. J. (2015). Managing the Impacts of Planned Urbanisation on Sustainable Agriculture in Kurdistan Region, Iraq. *Athens (ATINER) 's Conference Paper Series GEL2015-1654*.
- Baban, S. M. J. (2016). An Agro-Climatic Approach to Achieve Optimum Agriculture Production in Kurdistan, Iraq. *Middle East Journal of Agricultural Research*, 5(3), 240–246.
- Baban, S. M. J. (2024a). Using Geoinformatics to Utilize Forests as a Natural-Based Solution to Mitigate the Impacts of Climate Change on the Kurdistan Region, Iraq. *Proceedings of the Mediterranean Geosciences Union 4th Annual Conference*.
- Baban, S. M. J. (2024b). Planning For Adaptation to Global Climate Change in Iraq: A Proactive Approach. *International Journal of Advances in Science, Engineering and Technology*, 12(1). <http://iraj.in>.
- Benayas, J., Alonso, I., Alba Hidalgo, D., & Pertierra, L. (2010). The Impact of Universities on the Climate Change Process. https://doi.org/10.1007/978-3-642-10751-1_4
- Eilam, E., Prasad, V., & Widdop Quinton, H. (2019). Climate change education: Mapping the nature of climate change, the content knowledge and examination of enactment in upper secondary Victorian curriculum. *Sustainability*, 12(2), 591. <https://doi.org/10.3390/su12020591>
- Fahey, S. J. (2012). Curriculum change and climate change: Inside-outside pressures in higher education. *Journal of Curriculum Studies*, 44, 703–722.
- Filho, W. L. (ed.) (2010). *Universities and Climate Change: Introducing Climate Change to University Programmes*. Springer: Berlin. <https://doi.org/10.1007/978-3-642-10751-1>

- Filho, W. L., Frankenberger, F., Salvia, A. L., Azeiteiro, U., Alves, F., Castro, P., Will M., Platje, J., Lovren, V. O., Brandli, L., Price, E., Doni, F., Mifsud, M., & Veiga Ávila, L. (2021a). A framework for the implementation of the Sustainable Development Goals in University programmes. *Journal of Cleaner Production*, 299, Article 126915. <https://doi.org/10.1016/j.jclepro.2021.126915>
- Filho, W. L., Sima, M., Sharifi, A., Luetz, J. M., Salvia, A. L., Mifsud, M., Motunrayo Olooto, F., Djekic, I., Anholon, R., Rampasso, I., Kwabena Donkor, F., Pimenta Dinis, M. A., Klavins, M., Finnveden, G., Munashe Chari, M., Molthan-Hill, P., Mifsud, A., Sen, S. K., & Lokupitiya, E. (2021b). Handling climate change education at universities: An overview. *Environmental Sciences Europe*, 33, 109. <https://doi.org/10.1186/s12302-021-00552-5>
- Filho, W. L., Levesque, V., & Sivapalan, S. (2022). Social values and sustainable development: community experiences. *Environmental Sciences Europe*, 34, 67. <https://doi.org/10.1186/s12302-022-00641-z>
- Filho, W. L., Aina, Y. A., Dinis, M. A. P., Purcell, W., & Nagy, G. J. (2023). Climate change: Why higher education matters? *Science of the Total Environment*, 892, Article 164819. <https://doi.org/10.1016/j.scitotenv.2023.164819>
- Hama, R H., Hamad, R. T., & Aziz, F. H. (2014). Climate change in relation to rainfall and temperature in Erbil province, Kurdistan, Iraq. 18 Pages. Tunisian Association of Digital Geografic Information, 8Th international Congress Geo Tunis, 2-6 April.
- Hansen, J. A., & Lehmann, M. (2006). Agents of change: universities as development hubs. *Journal of Cleaner Production*, 14(9–11), 820–829. <https://doi.org/10.1016/j.jclepro.2005.11.048>
- Hedefalk, M., Almqvist, J., & Östman, L. (2015). Education for sustainable development in early childhood education: a review of the research literature. *Environmental Education Research*, 21, 975–990. <https://doi.org/10.1080/13504622.2014.971716>
- Holloway, A. & Fortune, G. (2018). Beyond fragility: Advancing skilled human capital for disaster risk reduction and resilience in Africa. Background paper for UNISDR Global Assessment of Risk 2019. <https://www.unisdr.org/we/inform/publications/65971>
- Houghton, J. T., Ding, Y., Griggs, D. J., Noguera, M., van der Linden, P. J., Dai, X., Maskell, K., Johnson, C. A. (Eds.). (2001). *Climate Change 2001: The Scientific Basis: Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.
- IPCC. (2018). Global warming of 1.5°C. IPCC: Intergovernmental Panel on Climate Change. <https://www.ipcc.ch/sr15/>
- Janabi, H. (2013). Climate Change Impact on Iraqi Water and Agriculture Sectors. *Middle East Oil and Gas News*, 56(10). <https://stiiraqdev.wordpress.com/2013/10/12/water-climate-change-iraq/>

- Kitagawa, K. (2017). Situating preparedness education within public pedagogy. *Pedagogy, Culture & Society*, 25(1), 1–13. <https://doi.org/10.1080/14681366.2016.1200660>
- Kwauk, C. (2021). Who's making the grade on climate change education ambition? <https://www.brookings.edu/opinions/whos-making-the-grade-on-climate-change-education-ambition/>
- Laurie, R., Nonoyama-Tarumi Y., Mckeown, R., & Hopkins, C. (2016). Contributions of education for sustainable development (ESD) to quality education: A synthesis of research. *Journal of Education for Sustainable Development*, 10(2), 226–242. <https://doi.org/10.1177/0973408216661442>
- Lehtonen, A., Salonen, A.O., & Cantell, H. (2019). Climate Change Education: A New Approach for a World of Wicked Problems. In J. W. Cook (Eds.), *Sustainability, Human Well-Being, and the Future of Education*. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-319-78580-6_11
- Lelieveld, J., Hadjinicolaou, P., Kostopoulou, E., Chenoweth, J., El Maayar, M., Giannakopoulos, C., Hannides, C., Lange, M. A., Tanarhte, M., Tyrlis, E., & Xoplaki, E. (2012). Climate change and impacts in the Eastern Mediterranean and the Middle East. *Climatic Change*, 114, 667–687. <https://doi.org/10.1007/s10584-012-0418-4>
- McCowan, T. (2020). *The impact of universities on climate change: a theoretical framework*. The Centre for Global Higher Education, Department of Education, University of Oxford.
- McKeown, R., & Hopkins, C. (2010). Rethinking climate change education: Everyone wants it, but what is it? *Green Teacher*, 89, 17–21.
- Mochizuki, Y., & Bryan, A. (2015). Climate Change Education in the Context of Education for Sustainable Development: Rationale and Principles. *Journal of Education for Sustainable Development*, 9, 4–26. <https://doi.org/10.1177/0973408215569109>
- Molthan-Hill, P., Worsfold, N., Nagy, G. J., Leal Filho, W., & Mifsud, M. (2019). Climate change education for universities: a conceptual framework from an international study. *Journal of Cleaner Production*, 226, 1092–1101. <https://doi.org/10.1016/j.jclepro.2019.04.053>
- Nosir, W. (2023). Climate Change: Consequences on Iraq's Environment. *Mesopotamia Journal of Agriculture*, 51(2), 131–146. <https://doi.org/10.33899/MAGRJ.2023.140391.1243>
- Preston, J.; Chadderton, C.; Kitagawa, K.; & Edmonds, C. (2015). Community response in disasters: an ecological learning framework. *International Journal of Lifelong Education*, 34(6), 727–753. <https://doi.org/10.1080/02601370.2015.1116116>
- Rieckmann, M. (2018). Learning to Transform the World: Key Competencies in Education for Sustainable Development. In A. Leicht, J. Heiss, & W. J. Byun (Eds.), *Issues and Trends in Education for Sustainable Development* (pp. 39–59). UNESCO.

Sheppard, S. R. J. (2012). *Visualizing Climate Change: A Guide to Visual Communication of Climate Change and Developing Local Solutions* (1st ed.). Routledge.
<https://doi.org/10.4324/9781849776882>

Stevenson, R., Nicholls, J., & Whitehouse, H. (2017). What Is Climate Change Education? *Curriculum Perspectives*, 37, 67–71. <https://doi.org/10.1007/s41297-017-0015-9>

United Nations Educational, Scientific, and Cultural Organization (UNESCO). (2016). *Getting climate-ready: A guide for schools on climate action*. Paris, France: UNESCO. <https://unesdoc.unesco.org/ark:/48223/pf0000246740>

United Nations Educational, Scientific, and Cultural Organization (UNESCO). (2021). *Getting every school climate ready. How countries are integrating climate change issues in education*. <https://unesdoc.unesco.org/ark:/48223/pf0000379591>

Vaughter, P., Wright, T., McKenzie, M., & Lidstone, L. (2013). Greening the Ivory Tower: A Review of Educational Research on Sustainability in Post-Secondary Education. *Sustainability*, 5, 2252–2271. <https://doi.org/10.3390/su5052252>

Contact email: saban2012@gmail.com