Course title: Water and Sustainable Development: Policies & Management

Course code: PPS 154	**No. of credits:** 2	**L-T-P:** 24-06-00	**Learning hours:** 30

Pre-requisite course code and title (if any): None

Department: Department of Policy & Management Studies

Course coordinator(s): Prof. Arun Kansal	**Course instructor(s):** Prof. Arun Kansal

Contact details: akansal@terisas.ac.in

Course type: Core	**Course offered in:** 2nd Semester

Course description

Water governance and management are integral to sustainable development as they directly influence human health, economic prosperity, environmental sustainability, and social equity. Effective governance frameworks and management practices facilitate the responsible use of water resources, ensuring that they can support current and future generations while fostering resilience to climate change and enhancing overall community well-being. Prioritizing water governance is crucial for achieving a more just, sustainable, and equitable world.

This course offers an in-depth examination of the critical relationship between water resources, sustainability, and governance. As global water challenges continue to escalate, understanding the fundamental water-related issues from a management and policy perspective is essential for future leaders and practitioners in the field. Through a combination of theoretical frameworks, practical insights, and real-world case studies, students will explore how effective water management and innovative policies can contribute to sustainable development goals.

The course is divided into four modules. The first module discusses the role of water as component of ecosystem and sustainability. Students will explore the integral role of water in sustainable development frameworks, interconnections between water, ecosystems, health, and economic stability, as well as the social justice dimensions associated with water access and equity. Focusing on water governance and management, the second module examines institutional frameworks, approaches, policy instruments, and stakeholder engagement mechanisms that shape water management practices. Students will investigate various governance models, including integrated water resources management (IWRM), participatory approaches, and the roles played by governmental and non-governmental entities in ensuring effective and equitable water management. This module also assesses the water management in India. The third module addresses the multifaceted challenges in water policy, including climate change, pollution, over-extraction, and competing demands. Students will critically analyse existing policies and frameworks that govern water use and sustainability while exploring innovative solutions, such as advanced technologies, public-private partnerships, and community-led initiatives aimed at enhancing resilience and addressing water scarcity. The final module will engage students with real-world case studies from various regions to understand best practices and effective policy initiatives in water management.

Learning objectives:

- To help students understand and analyze the role of water in sustainability discourse and its implications for sustainable development.
- To orient students to water governance frameworks and management strategies that influence water resource allocation and use.
- To help students identify the key challenges facing water policy and explore innovative solutions and technological advancements.
- To assist students to apply knowledge from case studies of successful water management practices and policy initiatives to develop actionable strategies for diverse contexts.

Course content

Module	Topic	L	T	P
1.	**Water in Sustainability Discourse** • Water as component of Ecosystem: Aquatic Ecosystems, Terrestrial Ecosystem; Nutrient Cycling; Hydrological Cycle; Climate Regulation; Soil Formation and Quality; Ecosystem Services • Global and national water distribution and availability issues • Linkages between water management and other sectors (health, agriculture, energy); Water-Energy-Food nexus	7	0	0
2.	**Political Economy of Water and its Governance** • Evolution of understanding of water security and governance	10	0	0

	• Transboundary water conflicts; Water access, ownership and rights; Privatization and commercialization of water • Water Governance Frameworks: Institutional frameworks for water management; Stakeholder roles: government, communities, NGOs, and private sector • Water Management Approaches: River basin approach; Watershed approach; Community management; Integrated Water Resources Management (IWRM) • Policy Instruments for Water Management: Economic instruments - pricing, taxes, and subsidies; Regulatory measures and compliance mechanisms • Water Management in India: Assessing water availability and quality (Water Stress, Water Quality Index); Status and Trends of Surface Water and Ground Water exploitation and pollution; Responsible factors – technical, policy and institutional factors; Sectoral analysis of water management (Agriculture, Domestic, Industry, Power – Thermal and Hydro); Water Interlinking; Regional consciousness and inter-state issues (water sharing)			
3.	**Challenges and Innovations in Water Policy** • Climate Change impacts; Pollution; Overexploitation; Water scarcity and competing demands; Habitat alteration due to human activities, including dam construction, land use change, and urbanization; Inequity in Access to Water; Fragmented Governance and Institutional Challenges; Public Awareness and Engagement; Infrastructure Gaps; Regulatory and Legislative Challenges • Adaptive water management strategies • Role of technology in enhancing water efficiency (smart water management) • Innovative practices in water recycling and desalination	7	0	0
4.	**Case Studies on Best Practices & Policy Initiatives** • International Cases, such as, Singapore: Integrated Water Management; Netherlands: Delta Works; Australia: Water Reform in the Murray-Darling Basin; Israel: Innovative Water Technologies; South Africa: The National Water Act; Ghana: Community-Based Water Management • Indian Cases, such as, *Jal Jeevan* Mission; Sustainable Groundwater Management in Rajasthan; Narmada River Valley Project; Andhra Pradesh: Krishna River Management; Integrated Watershed Management in Maharashtra; Karnataka: *Neeravari Naital* Scheme	0	6	0
	Total	**24**	**6**	**0**

Evaluation criteria:

Course grades will be based on the following criteria:

- **Minor Test-1:** Short-Answer Type Questions/Quizzes/MCQs (30%)
- **Minor Test-2:** Case Study Presentation on select cases based on Module-4 (20%)
- **Major Test:** Written Test/Term Paper Submission & Presentation (50%)

Learning outcomes

Upon completion of this course, candidates will:

1. have a comprehensive understanding of the complexities surrounding water resources in the context of sustainable development (All evaluations)
2. develop critical thinking and innovative approaches essential for addressing contemporary water challenges, thereby preparing students for impactful careers in water management, policy-making, and sustainable development (All evaluations)

Pedagogical approach

Classroom lectures; Student Seminars; Invited talks from Experts in particular domains including Practitioners and Senior/Superannuated Govt. Officers; Case studies.

Suggested Readings

Module 1:

- Loucks, D. P., & Gladwell, J. S. (1999). *Sustainability Criteria for Water Resource Systems*. Cambridge, UK: Cambridge University Press.
- Chorley, R. J. (1969). *Water, earth and man: a synthesis of hydrology, geomorphology and socioeconomic geography*. London: Methuen Young Books.
- Ehrlich, P. R., Holdren, J. P., & Ehrlich, A. H. (1978). *Ecoscience: population, resources, environment, 3rd edition*. San Franscisco: W. H. Freeman.
- Shaw, E. M. (1994). *Hydrology in Practice, 3rd edition*. London: Chapman & Hall.
- Rodríguez-Iturbe, I., & Porporato, A. (2005). *Ecohydrology of Water-Controlled Ecosystems: Soil Moisture and Plant Dynamics*. Cambridge: Cambridge University Press.
- Horne, A. C., Webb, J. A., Stewardson, M. J., Richter, B., & Acreman, M. (Eds.) (2017). *Water for the Environment: From Policy and Science to Implementation and Management*. London, UK: Academic Press (Elsevier).
- Gunawardena, E. R. N., Gopal, B., & Kotagama, H. (Eds.) (2012). *Ecosystem and Integrated Water Resources Management in South Asia*. New Delhi: Routledge.
- Chakraborty, S., Chatterjee, A., & Kumar, P. (Eds.) (2025). *Urban Water Ecosystems in Africa and Asia: Challenges and Opportunities for Conservation and Restoration*. Oxon & New York: Routledge.
- Arya, M. (2019). *Spatial Ecology of Water*. AADI Centre.
- Polunin, N. V. C. (Ed.) (2010). *Aquatic Ecosystems: Trends and Global Prospects*. Cambridge: Cambridge University Press.
- Wohl, E. (2017). *Sustaining River Ecosystems and Water Resources*. Cham, Switzerland: Springer.
- Kholod, N., Evans, M., Khan, Z., Hejazi, M., & Chaturvedi, V. (2021). Water-energy-food nexus in India: A critical review. *Energy and Climate Change*, *2*, 100060. https://doi.org/10.1016/j.egycc.2021.100060

Module 2:

- Pahl-Wostl, C. (2015). *Water Governance in the Face of Global Change: From Understanding to Transformation*. Cham: Springer Nature Switzerland AG.
- Chadha, G., & Pandya, A. B. (Eds.) (2021). *Water Governance and Management in India: Issues and Perspectives, Volume 2*. Singapore: Springer Verlag.
- Katko, T. S., Juuti, P. S., Schwartz, K., & Rajala, R. P. (Eds.) (2013). *Water Services Management and Governance: Lessons for a Sustainable Future*. London, UK: IWA Publishing.
- Grigg, N. S. (2010). *Governance and Management for Sustainable Water Systems*. London, UK: IWA Publishing.
- Varis, O., Tortajada, C., & Biswas, A. K. (Eds.) (2008). *Management of Transboundary Rivers and Lakes*. Springer.
- Biswas, A. K., Tortajada, C., & Rohner, P. (Eds.) (2018). *Assessing Global Water Megatrends*. Singapore: Springer Nature Singapore Pte. Ltd.
- World Water Council (Ed.) (2018). *Global Water Security: Lessons Learnt and Long-Term Implications*. Singapore: Springer Nature Singapore Pte. Ltd.
- Scudder, T. (2019). *Large Dams: Long Term Impacts on Riverine Communities and Free Flowing Rivers*. Singapore: Springer Nature Singapore Pte. Ltd.
- Haie, N. (2021). *Transparent Water Management Theory: Sufficiency in Sequity*. Singapore: Springer Nature Singapore Pte. Ltd.
- Kumar, M. D., Bassi, N., & Kumar, S. (2022). *Drinking Water Security in Rural India: Dynamics, Influencing Factors, and Improvement Strategy*. Singapore: Springer Nature Singapore Pte. Ltd.
- Loucks, D. P., Stedinger, J. R., & Haith, D. A. (1981). *Water Resource Systems Planning and Analysis*. Englewood Cliffs, NJ: Prentice Hall.
- Simonvic, S. P. (2009), *Managing water resources: Methods and tools for a system approach*. UNESCO Publishing, France.
- Prakash, A., Kumar, N., Chhatre, A., Thakkar, S., & Dar, A. (2024). Navigating India's groundwater crisis: legal and institutional perspectives on regulation and conservation. *Water Policy*, *26*(8), 835–855. https://doi.org/10.2166/wp.2024.123.
- Mukherji, A. (2022). Sustainable Groundwater Management in India Needs a Water-Energy-Food Nexus Approach. *Applied Economic Perspectives and Policy*, *44*(1), 394-410. https://doi.org/10.1002/aepp.13123.

Module 3:

- Hüttl, R. F., Bens, O., Bismuth, C., & Hoechstetter, S. (Eds.) (2016). *Society - Water - Technology: A Critical Appraisal of Major Water Engineering Projects*. Cham, Switzerland: Springer International Publishing AG.
- Biswas, A. K., & Tortajada, C. (Eds.) (2022). *Water Security Under Climate Change*. Singapore: Springer Nature Singapore Pte. Ltd.
- Biswas, A. K., & Tortajada, C. (Eds.) (2016). *Water Security, Climate Change and Sustainable Development*. Singapore: Springer Science + Business Media Singapore.
- Edalat, F. D., & Abdi, M. R. (2017). *Adaptive Water Management: Concepts, Principles and Applications for Sustainable Development*. Cham, Switzerland: Springer International Publishing AG.
- Mysiak, J., Henrikson, H. J., Sullivan, C., Bromley, J. & Pahl-Wostl, C. (Eds.) (2010). *The Adaptive Water Resource Management Handbook*. London, UK: Earthscan. https://www.pseau.org/outils/ouvrages/earthscan_ltd_the_adaptive_water_resource_management_handbook_2010.pdf.
- Pahl-Wostl, C., Kabat, P., & Möltgen, J. (Eds.) (2007). *Adaptive and Integrated Water Management: Coping with Complexity and Uncertainty*. Heidelberg: Springer-Verlag Berlin.
- Evans, R. G., & Sadler, E. J. (2008). Methods and technologies to improve efficiency of water use. *Water Resources Research*, *44*(7). https://doi.org/10.1029/2007WR006200.
- Geetha Varma, V. (2021). Water-efficient technologies for sustainable development. *Current Directions in Water Scarcity Research*, *6*, 101-128. https://doi.org/10.1016/B978-0-323-91838-1.00009-9.
- Antu, U. B., Islam, M. S., Ahmed, S., Arifuzzaman, M., Saha, S., Mitu, P. R., Sarkar, A. R., Mahiddin, N. A., Ismail, Z., Ibrahim, K. A., & Idris, A. M. (2024). Emerging technologies for efficient water use in agriculture: A review of current trends and future directions. *Journal of Water Process Engineering*, *68*, 106317. https://doi.org/10.1016/j.jwpe.2024.106317.
- Pérez-Urdiales, M., & García-Valiñas, M. Á. (2016). Efficient water-using technologies and habits: A disaggregated analysis in the water sector. *Ecological Economics*, *128*, 117-129. https://doi.org/10.1016/j.ecolecon.2016.04.011.
- Shokri, A., & Sanavi Fard, M. (2022). A sustainable approach in water desalination with the integration of renewable energy sources: Environmental engineering challenges and perspectives. *Environmental Advances*, *9*, 100281. https://doi.org/10.1016/j.envadv.2022.100281.
- Shiferaw, B. A., Reddy, V. R., & Sharma, B. (2023). Groundwater governance under climate change in India: lessons based on evaluation of World Bank interventions. *International Journal of Water Resources Development*, *40*(3), 401–424. https://doi.org/10.1080/07900627.2023.2207694.
- Hong, S., Park, K., Kim, J., Alayande, A. B., & Kim, Y. (Eds.) (2023). *Seawater Reverse Osmosis (SWRO) Desalination: Energy consumption in plants, advanced low-energy technologies, and future developments for improving energy efficiency*. London, UK: IWA Publishing.
- Salinas-Rodriguez, S. G., & Villacorte, L. O. (Eds.) (2023). *Experimental Methods in Desalination and Water Treatment*. London, UK: IWA Publishing.
- Bhattacharya, P., Armienta, M. A., Mahlknecht, J., & Kumar, M. (Eds.) (2023). *Best Practice Guide on Control of Fluoride in Drinking Water*. London, UK: IWA Publishing.
- Bryjak, M., Kabay, N., Rivas, B. L., & Bundschuh, J. (Eds.) (2016). *Innovative Materials and Methods for Water Treatment: Solutions for Arsenic and Chromium Removal*. London, UK: Taylor & Francis Group.

Module 4:

- Chen, D. C., Maksimovic, C., & Voulvoulis, N. (2011). Institutional capacity and policy options for integrated urban water management: a Singapore case study. *Water Policy*, *13*(1), 53–68. https://doi.org/10.2166/wp.2010.073.
- Jensen, O., & Nair, S. (2019). Integrated Urban Water Management and Water Security: A Comparison of Singapore and Hong Kong. *Water*, *11*(4), 785. https://doi.org/10.3390/w11040785.
- Hu, X. (2020). Sustainable Water Demand Management: A Case Study of Singapore's Accommodation Sector. *IOP Conference Series: Earth and Environmental Science*, *576*, 012005. https://iopscience.iop.org/article/10.1088/1755-1315/576/1/012005.

- Banerjee, C., Bhaduri, A., & Saraswat, C. (2022). Digitalization in Urban Water Governance: Case Study of Bengaluru and Singapore. *Frontiers in Environmental Science*, *10*, 816824. https://doi.org/10.3389/fenvs.2022.816824.
- Verdon-Kidd, D. C., Sandi, S. G., Metcalfe, A. G., & Kidd, L. J. (2023). Challenges of classifying and mapping perennial freshwater systems within highly variable climate zones: A case study in the Murray Darling Basin, Australia. *Science of The Total Environment*, *905*, 167260. https://doi.org/10.1016/j.scitotenv.2023.167260.
- Connell, D., & Grafton, R. Q. (2011). Water reform in the Murray-Darling Basin. *Water Resources Research*, *47*(12). https://doi.org/10.1029/2010WR009820.
- Samnakay, N., Alexandra, J., Wyborn, C. A., & Bender, I. (2024). Climate adaptive water policy in Australia's Murray Darling basin: soft options or hard commitments? *Ecology & Society*, *29*(1), 1. https://doi.org/10.5751/ES-14578-290101.
- Marin, P., Tal, S., Yeres, J., & Ringskog, K. (2017). *Water Management in Israel: Key Innovations and Lessons Learned for Water-Scarce Countries*. Washington, DC: World Bank. https://openknowledge.worldbank.org/server/api/core/bitstreams/2577d429-0114-5d64-884e-8ba80ecd82f6/content.
- Friedler, E. (2000). Water reuse — An integral part of water resources management:: Israel as a case study. *Water Policy*, *3*(1), 29-39. https://doi.org/10.1016/S1366-7017(01)00003-4.
- Kramer, I., Tsairi, Y., Roth, M. B., Tal, A., & Mau, Y. (2022). Effects of population growth on Israel's demand for desalinated water. *Npj Clean Water*, *5*(1), 1-7. https://doi.org/10.1038/s41545-022-00215-9.
- Svahn, K. (2011). Women's Role and Participation in Water Supply Management - The Case Study of the Republic of Ghana. Institutionen för Geovetenskaper, Uppsala Universitet. https://www.diva-portal.org/smash/get/diva2:482130/FULLTEXT01.pdf4.
- Sedegah, D. D., Agyekum, M. W., & Kyeremeh, B. (2023). Local-level water conservation and management practices in rural communities: A case study in Dormaa Municipality, Bono Region, Ghana. *Irrigation and Drainage*, *72*(4), 1095-1108. https://doi.org/10.1002/ird.2849.
- Abunyewah, M., Erdiaw-Kwasie, M. O., Arhin, P., Acheampong, M. Y., & Okyere, S. A. (2022). Rural water project planning and evaluation in Ghana: a new methodological perspective. *Water Policy*, *24*(12), 1913–1929. https://doi.org/10.2166/wp.2022.157.
- Maphela, B., & Cloete, F. (2019). Johannesburg's implementation of the National Water Act, 1998 in Soweto, South Africa. *Development Southern Africa*, *37*(4), 535–552. https://doi.org/10.1080/0376835X.2019.1647834.
- Stein, R. (2002). Water Law in a Democratic South Africa: A Country Case Study Examining the Introduction of a Public Rights System. Allocating and Managing Water for a Sustainable Future: Lessons from Around the World (Summer Conference, June 11-14). https://scholar.law.colorado.edu/allocating-and-managing-water-for-sustainable-future/66.
- Tewari, DD. (2009). A detailed analysis of evolution of water rights in South Africa: an account of three and a half centuries from 1652 AD to present. *Water SA*, *35*(5), 693-710. Retrieved November 30, 2024, from http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S1816-79502009000500019&lng=en&tlng=en.
- Olley, J., Cvitanovic, M., Ginige, T., & Bunt-MacRury, L. (2024). A systematic literature review of sustainable water management in South Africa. *Sustainable Water Resources Management*, *10*, 162. https://doi.org/10.1007/s40899-024-01135-x.
- Sankala Foundation. (2024). Jal Jeevan Mission - Har Ghar Jal: A Study of Access to Clean Tap Water to Every Rural Home in India. Sankala Foundation, New Delhi.
- Sahoo, M. K., Divi, S., Rathod, B., & Vekariya, H. (2023). India's Prospects for Attaining Sustainable Development Goals on Health & Sanitation: A Critical Analysis of Swachh Bharat Abhiyan & Jal Jeevan Mission. *International Journal of Environmental Sciences*, *9*(2), 74-87. https://www.theaspd.com/resources/5.%20Manoj%20K.%20Sahoo.pdf.
- Negi, U., Chaturvedi, K., & Bassi, N. (2023). India's Jal Jeevan Mission is Putting Women at the Centre of Water Access. https://www.ceew.in/blogs/how-jal-jeevan-mission-aims-to-provide-safe-clean-water-access-for-rural-households-and-empower-women-in-india.
- Singh, A. P., & Bhakar, P. (2021). Development of groundwater sustainability index: a case study of western arid region of Rajasthan, India. *Environment, Development and Sustainability*, *23*, 1844–1868. https://doi.org/10.1007/s10668-020-00654-9.
- Reddy, V. R. (2010). Water sector performance under scarcity conditions: a case study of Rajasthan, India. *Water Policy*, *12*(5), 761–778. https://doi.org/10.2166/wp.2010.135.

- CEEW. Water Management Programme: Tarun Bharat Sangh. Framework for India's Sustainable Agriculture Initiatives. https://www.ceew.in/sustainable-agriculture-initiatives/tarun-bharat-sangh-johad-water-conservation-harvesting-and-revitalisation.
- Venot, J.-P., Bharati, L., Giordano, M., & Molle, F. (2011). Beyond water, beyond boundaries: spaces of water management in the Krishna river basin, South India. *The Geographical Journal*, *177*(2), 160–170. http://www.jstor.org/stable/41238025.
- Bharati, L., Anand, B. K., & Smakhtin, V. (n.d.). Analysis of the Inter-basin Water Transfer Scheme in India: A Case Study of the Godavari–Krishna Link. https://publications.iwmi.org/pdf/H041799.pdf.
- Bhaduri, A., Amarasinghe, U. A., & Shah, T. (2008). Benefits of irrigation water transfers in the National River Linking Project: a case study of Godavari (Polavaram)-Krishna link in Andhra Pradesh. Conference Papers h041803, International Water Management Institute.

Student responsibilities

- At least 75% attendance will be necessary to be able to appear for the final exam.
- Active classroom participation; Critical reflections and timely submission according to the evaluation criterion.

Course Outline prepared by: Prof. Arun Kansal

Course Reviewers

1. Prof. Ajay R. Tembhurkar, Professor of Environmental Engineering, Department of Civil Engineering, Visvesvaraya National Institute of Technology (VNIT), Nagpur, Maharashtra, India.
2. Dr Geoff Goodwin, Faculty of Global Political Economy, School of Politics and International Studies (POLIS), University of Leeds, Leeds, United Kingdom.

Additional Information

This Course outline was approved in the 60th Academic Council Meeting held on 24th December 2024 at TERI School of Advanced Studies, New Delhi.