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Hydro Criminality Today: Understanding Causes, Consequences and Legal Responses

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Abstract

Hydro criminality involves unlawful acts targeting water resources, such as illegal extraction, pollution, corruption, and sabotage. It emerges from a mix of environmental stress, poor governance, inequality, and political-corporate collusion. As climate change worsens water scarcity, competition intensifies, encouraging criminal activity. Weak institutions and fragmented regulation provide opportunities for exploitation by criminal networks. The impacts of hydro criminality are wide-ranging. Human health is threatened by waterborne diseases due to contamination. Environmental damage includes depleted aquifers and destroyed ecosystems. Economically, it harms agriculture, fisheries, and tourism. Insecurity rises as water-related crimes spark conflicts and are weaponized by criminal groups. Legal responses span national and international law, but enforcement is often weak or fragmented. National laws suffer from unclear rights and poor implementation, while international frameworks lack universal enforcement. Environmental and criminal law intersections complicate transboundary crime responses. Regional cases show how hydro criminality varies: tanker mafias in India, agricultural theft in South Africa, Flint's water crisis in the U.S., water as a weapon in the Middle East, and Latin American resistance to privatization. India's courts increasingly affirm water as a public right. Effective solutions include legal reform, community governance, transparency, and participatory decision-making to protect water resources.

Keywords: Hydro criminality, water theft, pollution, governance, water scarcity, legal frameworks, water conflict, water commodification.

I. Introduction

Water, essential for life, has increasingly become the target of criminal activity in the 21st century. "Hydro criminality" includes unlawful actions such as illegal extraction, pollution, infrastructure sabotage, and corruption in water governance systems. These activities are a growing threat amid rising water scarcity, climate change, and competition for diminishing resources **(Brisman et al. 2018).** Hydro criminality must be understood in the context of the global water crisis and the Anthropocene, where human activity dominates climate and environmental change. As climate change intensifies, freshwater resources face unprecedented pressure, making water a prime target for exploitation **(Agnew, 2012).** In water-stressed regions, hydro criminality worsens existing vulnerabilities. Illegal diversion, pollution,

and monopolization of water resources have widespread impacts on communities, ecosystems, and economies. Marginalized populations, lacking political power, are often the most affected **(Empinotti et al. 2019).** Addressing hydro criminality is critical not just for environmental protection, but for sustainable development, public health, social equity, and conflict prevention. In regions like Sub-Saharan Africa, South Asia, and the Middle East, where water scarcity is severe, hydro criminality can jeopardize access to safe drinking water and sanitation, becoming a life-or-death issue **(Gleick and Heberger, 2014).** This article provides a comprehensive analysis of hydro criminality, exploring its ecological, social, economic, and political dimensions. It examines causes, consequences, legal frameworks, and policy strategies to prevent and address water crimes. The focus is on regions where water stress intersects with governance challenges, offering an interdisciplinary framework from criminology, hydrology, political ecology, and environmental law to tackle this emerging threat.

II. Understanding Hydro Criminality

Conceptual Framework: Hydro criminality is a distinct form of environmental crime, involving intentional acts that violate laws and regulations governing water resources. Unlike accidental contamination or mismanagement, hydro criminality entails deliberate actions with criminal intent, causing harm to the environment, communities, or public interests related to water **(Johnson et al. 2016).** To define hydro criminality, it's crucial to distinguish it from negligence or mismanagement. While both can result in similar harms, hydro criminality is driven by profit, power, or competitive advantage, making legal responses and remediation more urgent **(White, 2018).** An interdisciplinary approach offers a comprehensive framework for understanding hydro criminality. Criminological perspectives, especially green criminology, examine motivations, opportunity structures, and how power dynamics influence what is considered criminal **(White, 2018).** Hydrological science clarifies how these activities disrupt natural water systems, helping define thresholds for overexploitation and pollution. Political ecology highlights how water crimes intersect with political and economic structures, often enabling powerful actors to exploit resources with impunity **(Swyngedouw, 2015).** Legal frameworks vary across jurisdictions, complicating the consistent identification and prosecution of hydro crimes. While some are explicitly codified (e.g., industrial pollution), others exist in grey areas, such as excessive groundwater extraction where legal limits are unclear. Finally, the environmental justice aspect is essential, as hydro criminality disproportionately affects marginalized communities, making it not only a legal but also an ethical issue **(Zeitoun and Warner, 2006).**

Typologies of Hydro Crimes: Water crimes take various forms across different regions, requiring a typology to help understand and address them effectively. Water theft is one of the most direct forms of hydro criminality**(Box 1).** This includes illegal groundwater extraction through unauthorized wells, a significant issue in areas like Punjab, India, and California's Central Valley. In urban settings, water theft often involves illegal connections to municipal systems, with organized "water mafias" controlling access, especially in water-scarce megacities in the Global South **(Rusca et al. 2017).** Pipeline tapping, where water is diverted from public infrastructure for private use, is another form of theft, with some regions losing up to 50% of municipal water to illegal tapping. Water pollution crimes involve the intentional discharge of contaminants. Industrial dumping of untreated effluents, often concealed, avoids waste treatment costs while harming communities and ecosystems. Agricultural runoff with banned pesticides or excessive fertilizers is another key pollution source, challenging enforcement due to its non-point nature. Mining operations often contribute to pollution via acid mine drainage, heavy metals, and improper tailings disposal, severely impacting downstream areas **(Udiba et al. 2020).** Corruption in water projects includes bribery for infrastructure contracts, embezzlement of funds, and manipulation of water quality testing. Tender manipulation ensures that politically connected companies receive contracts, often leading to substandard infrastructure. Regulatory capture where industry interests influence water oversight permits ongoing pollution with few consequences **(Woodhouse and Muller, 2017).** Privatization crimes arise from the commodification of water. These include price gouging, failure to meet service obligations, and exploitation of regulatory gaps to acquire water rights cheaply, which are then sold at premium prices **(Loftus et al. 2019).** Violence and conflict are increasingly associated with water scarcity. Water mafias use intimidation to control illegal networks, while infrastructure sabotage occurs in conflict zones. Threats and killings of water rights activists and environmental defenders are rising, particularly against those opposing water-intensive extractive projects or pollution.

Box 1 Basic Concepts Used in this Paper

Antimicrobial resistance (AMR): The ability of microorganisms such as bacteria, viruses, and fungi to resist the effects of medications, makes infections harder to treat and increases the risk of disease spread, severe illness, and death **(WHO, 2020).**

Aquatic ecosystem: A water-based environment, including freshwater and marine systems, where living organisms interact with each other and with the physical environment **(Dodds and Whiles, 2010).**

Aquatic food resources: Edible resources are derived from aquatic ecosystems, including fish, crustaceans, molluscs, and aquatic plants, which are vital for food security and livelihoods **(FAO, 2022).**

Biodiversity: The variety of life in all its forms, including species diversity, genetic diversity, and ecosystem diversity, is essential for ecosystem functioning and resilience **(CBD, 2020).**

Blockchain technology: A decentralized digital ledger system that records transactions across many computers, enhancing transparency, traceability, and security, including in environmental and water governance **(Tapscott and Tapscott, 2016).**

Capacity building: The process of developing and strengthening the skills, resources, and abilities of individuals, institutions, and communities to achieve sustainable development goals **(UNDP, 2009).**

Carbon sequestration: The long-term storage of carbon dioxide or other forms of carbon to mitigate climate change, commonly through forests, soil, and oceans **(IPCC, 2021).**

Civic science (Citizen science): The participation of the public in scientific research and data collection contributes to policy-making and environmental monitoring **(Bonney et al. 2014).**

Climate financing: Funding from public, private, and alternative sources to support mitigation and adaptation actions that address climate change **(UNFCCC, 2023).**

Corporate pollution: Environmental degradation is caused by industrial and commercial entities through emissions, waste disposal, and exploitation of natural resources **(Jaffe et al. 1995).**

Criminal law: The body of law defines criminal offences, regulates the apprehension, charging, and trial of suspected persons, and sets penalties for convicted offenders **(Ashworth and Horder, 2013).**

Decentralisation of water: The transfer of water governance responsibilities from central authorities to local institutions or communities is aimed at enhancing efficiency, equity, and participation **(Meinzen-Dick and Nkonya, 2007).**

Displacement: The forced movement of people from their homes, often due to development projects, natural disasters, or conflict, with significant social and environmental impacts **(Cernea, 2000).**

Drone technology: Unmanned aerial systems (UAS) used for surveillance, data collection, mapping, and monitoring, are increasingly applied in agriculture, water management, and disaster response **(Colomina and Molina, 2014).**

Ecological damage: The harm caused to ecosystems through human or natural activities that disrupt biological diversity, ecosystem functions, or natural processes **(UNEP, 2016).**

Ecological integrity: The ability of an ecosystem to support and maintain a balanced, adaptive community of organisms with biological diversity, composition, and functioning comparable to natural habitats **(Parrish et al. 2003).**

Ecological restoration: The process of assisting the recovery of ecosystems that have been degraded, damaged, or destroyed, aims to re-establish ecological processes and biodiversity **(SER, 2004).**

Environmental crime: Illegal acts that directly harm the environment, such as illegal logging, wildlife trafficking, pollution, and unregulated resource extraction **(UNODC, 2020).**

Environmental health: The branch of public health is concerned with all aspects of the natural and built environment affecting human health, including air and water quality, chemical safety, and sanitation **(WHO, 2023).**

Environmental inspectors: Authorized personnel who monitor, investigate, and ensure compliance with environmental laws and regulations, often conducting field inspections and reporting violations **(OECD, 2009).**

Environmental law: A body of laws and regulations aimed at protecting the environment by controlling pollution, conserving natural resources, and promoting sustainable development **(Birnie et al. 2009).**

Environmental prosecutors: Legal professionals specialise in prosecuting crimes that impact the environment, often working within specialized environmental courts or units to uphold environmental justice **(Faure and Svatikova, 2012).**

Environmental services (Ecosystem services): Benefits provided by ecosystems that support human life, include provisioning (food, water), regulating (climate, disease), supporting (nutrient cycles), and cultural services (spiritual, recreational) **(MEA, 2005).**

Food chain: A linear sequence of organisms through which nutrients and energy pass as one organism eats another, forming a fundamental part of ecosystem functioning **(Odum and Barrett, 2005).**

Freedom of information: The right of individuals to access information held by public bodies, promotes transparency, accountability, and public participation in governance **(UNESCO, 2017).**

Green criminology: A subfield of criminology that studies environmental harms, crimes against nature, and social justice issues related to environmental regulation and protection **(White, 2013).**

Groundwater extraction: The process of withdrawing water stored beneath the earth's surface for agricultural, industrial, or domestic use, often leads to overuse and depletion **(Gleeson et al. 2012).**

Human security: A concept that prioritizes protecting individuals from chronic threats like hunger, disease, repression, and sudden disruptions in daily life **(UNDP, 1994).**

Hydro criminality: Criminal activities related to water resources, including illegal extraction, pollution, corruption, and denial of access, often involve institutional complicity **(Loftus, 2009; UNODC, 2021).**

Hydrological science: The scientific study of water in the environment, including its distribution, movement, and properties on and below the Earth's surface **(Hornberger et al. 2014).**
Illegal water activity: Any unauthorized or unlawful use of water resources, such as unlicensed extraction, pollution, tampering with infrastructure, or diversion **(UNODC, 2021).**
Illegal water vendor: An individual or entity that supplies water without legal authorization, often exploits informal markets, particularly in water-scarce urban areas **(Kooy and Bakker, 2008).**
Indigenous community: Ethnically distinct groups have historical continuity with pre-colonial societies and maintain unique cultural, linguistic, and spiritual connections to their ancestral lands **(UN, 2007).**
Landsat: A series of Earth-observing satellite missions jointly managed by NASA and the USGS, providing continuous multispectral imagery for monitoring land use, vegetation, and environmental change **(USGS, 2023).**
Legal accountability: The obligation of individuals, institutions, and governments to be held legally responsible for their actions, particularly when violating environmental or human rights laws **(ICJ, 2005).**
Legal pluralism: The coexistence of multiple legal systems within a given society, such as customary, religious, and formal state laws **(Merry, 1988).**
Migration: The movement of people across regions or countries due to economic, social, political, or environmental reasons, often affecting and affected by access to water and land **(IOM, 2019).**
Nutrient pollution: Excessive input of nutrients, primarily nitrogen and phosphorus, into water bodies, leads to eutrophication, algal blooms, and loss of aquatic biodiversity **(EPA, 2022).**
Parallel water economy: An informal or unregulated water market operating outside state control, often emerging in response to unreliable public supply **(Ahlers et al. 2014).**
PFAS (Per- and poly-fluoroalkyl substances): A group of man-made chemicals used in industrial applications that are persistent in the environment and pose serious health risks **(EPA, 2023).**
Political ecologist: A scholar or practitioner who studies the relationships between political, economic, and social factors with environmental issues and changes **(Robbins, 2012).**
Political violence: Violence is perpetrated to achieve political objectives, including state repression, insurgency, terrorism, and conflict over resources like water or land **(Galtung, 1990).**
Pollution crimes: Criminal acts that result in environmental pollution, such as illegal dumping of waste, emissions violations, or unauthorized discharge into water bodies **(UNEP-Interpol, 2016).**
Remote sensing: The acquisition of information about an object or phenomenon without direct contact, typically using satellite or aerial sensors to monitor land and water conditions **(Campbell and Wynne, 2011).**
Restorative justice: A legal philosophy that focuses on repairing the harm caused by crime through inclusive processes involving victims, offenders, and communities **(Zehr, 2002).**
Sentinel imagery: Satellite images produced by the European Space Agency's Sentinel program are used for Earth observation including land cover, climate change, and water management **(ESA, 2023).**
Silos: Isolated organizational structures or systems that lack communication and coordination, often hinder integrated water and environmental management **(UN-Water, 2013).**
Theories of environmental crimes: Conceptual frameworks explaining environmental offences, including green criminology, routine activity theory, and environmental justice perspectives **(White, 2011).**
Transboundary water resources: Water bodies such as rivers, lakes, and aquifers that cross or demarcate international boundaries and are shared by two or more nations **(UNESCO, 2019).**
Transboundary water tension: Conflicts or political frictions arising between countries or regions due to shared water resources are often linked to competing usage, scarcity, or infrastructure development **(Zeitoun and Mirumachi, 2008).**
Transboundary water: Water that flows across or forms part of international or administrative boundaries, requires cooperative governance frameworks **(UN Water, 2021).**
Water access: The ability of individuals or communities to obtain safe, sufficient, and affordable water for personal and domestic use **(WHO/UNICEF, 2021).**
Water conflicts: Disputes between stakeholders over water use, allocation, or quality, are often driven by scarcity, inequality, or governance failures **(Gleick, 1993).**
Water crimes: All forms of illegal water-related activities, including theft, pollution, corruption, and fraudulent allocation of water resources **(UNODC, 2021).**
Water crisis: A situation where water availability fails to meet demand due to overuse, pollution, or climate impacts, often resulting in socio-economic and health challenges **(UNESCO, 2020).**
Water cycling: The continuous movement of water within the Earth and atmosphere through processes like evaporation, condensation, precipitation, and infiltration **(USGS, 2023).**
Water efficiency: The use of improved technologies and practices that deliver equal or better services while reducing water use and waste **(FAO, 2012).**
Water governance: The political, social, economic, and administrative systems that influence water use and management, include regulation, access, and accountability **(OECD, 2015).**
Water inequality: Disparities in access to safe and affordable water services across regions, socio-economic groups, or genders, are often linked to policy and infrastructure gaps **(UN-Water, 2023).**
Water mafias: Informal or criminal groups control and profit from the illegal supply and distribution of water, often in urban areas lacking state provision **(Puy and Hidalgo, 2020).**
Water management: The process of planning, developing, distributing, and managing the use of water resources efficiently and sustainably **(World Bank, 2017).**
Water offences: Violations of water-related laws, including illegal abstraction, pollution, tampering with infrastructure, and fraudulent water allocation **(Faure and Heine, 2017).**

Water policy: A set of formal rules, strategies, and decisions made by governments or institutions to manage water resources, ensuring sustainability and equity **(UNESCO, 2012).**
Water pollution: The contamination of water bodies by harmful substances degrades water quality, ecosystems, and human health **(EPA, 2022).**
Water resource asset: Water is considered a valuable natural, economic, or strategic resource essential for societal development and environmental balance **(Global Water Partnership, 2000).**
Water rights: Legal entitlements granted to individuals, communities, or institutions to use water resources for specific purposes **(Hodgson, 2006).**
Water scarcity: A situation where water demand exceeds available resources in a region, either due to natural shortage or mismanagement **(WWAP, 2015).**
Water stress: The ratio of total freshwater withdrawn to the total renewable freshwater resources, indicating pressure on water availability **(FAO, 2021).**
Water theft: The unauthorized abstraction or diversion of water resources, often involving tampering with infrastructure or bypassing legal mechanisms **(UNODC, 2021).**
Water war: Armed conflict or political confrontation over water resources, usually in transboundary or water-scarce regions **(Shah, 2010).**
Whistleblower: An individual who exposes illegal or unethical activities within an organization, including environmental crimes or water-related corruption **(UNODC, 2019).**

Sources: Compiled from different literatures on water and its related studies

III. Causes of Hydro Criminality

Environmental and Resource Pressures: The growing scarcity of freshwater resources creates conditions conducive to hydro criminality. Climate change is a key driver, altering precipitation patterns, accelerating glacial melt, intensifying droughts, and disrupting hydrological cycles. The World Resources Institute projects that by 2040, 33 countries will face extremely high water stress, heightening the economic value of water and fueling illicit appropriation **(Luo et al. 2015).** As water availability declines, competition intensifies across agricultural, industrial, municipal, and ecosystem needs. Economic pressures from limited or costly legitimate access often push actors toward illegal extraction methods. For example, during California's 2012-2016 drought, numerous cases of water theft from hydrants, canals, and private supplies were documented **(Griswold, 2016).** Depleting groundwater levels is a particularly severe driver of hydro criminality. As aquifers shrink, deeper wells and more powerful pumps are needed, disadvantaging smaller users. This often leads to illegal drilling, as seen in India's Punjab region, where wealthy landowners bypass regulations through corruption **(Cullet et al. 2019).** The unequal distribution of water resources exacerbates criminal exploitation. In many urban areas of the Global South, water mafias exploit this inequality by illegally tapping municipal lines and reselling water at inflated prices. In Lima, Peru, residents in informal settlements pay up to 10 times more for water than affluent neighbourhoods **(Ioris, 2016).** Climate change also intensifies existing vulnerabilities. Extreme weather events, such as droughts and floods, disrupt infrastructure and create enforcement challenges. During droughts, desperate citizens may resort to water theft, while floods can overwhelm wastewater systems, allowing industries to discharge untreated effluents with reduced detection risk. Source pressures are also seen in transboundary contexts, where upstream diversions or pollution impact downstream users. When formal treaties fail to ensure equitable distribution, communities or states may engage in unauthorized actions, as seen in disputes along the Tigris-Euphrates, Nile, and Mekong rivers **(Zeitoun and Warner, 2006).**

Weak Governance and Regulation: Institutional fragmentation is a key governance weakness that facilitates hydro criminality. Water management often involves multiple agencies with overlapping mandates but poor coordination, creating regulatory gaps and enforcement confusion. For example, in the U.S., water quality, allocation, and infrastructure responsibilities are split between federal, state, and local authorities, allowing illegal activities to go undetected **(Bakker, 2010).** Limited regulatory capacity is another critical vulnerability. Water management agencies frequently lack the personnel, resources, and funding to monitor vast water networks. In countries like Kenya, the Water Resources Authority, responsible for overseeing water extraction, operates with fewer than 300 enforcement officers, making effective monitoring impossible **(Kameri-Mbote and Kariuki, 2015).** The absence of comprehensive legal frameworks also enables criminal activities. Many regions lack laws regulating groundwater extraction, leading to unmonitored pumping and aquifer depletion. Even where laws exist, unclear provisions and loopholes often allow exploitation **(Gleick and Heberger, 2014).** Enforcement challenges compound these issues. Remote water infrastructure is difficult to monitor, especially in rural or rugged areas. Violations often go undetected until environmental damage is evident, and prosecuting these crimes is hindered by technical difficulties in proving the source of pollution or unauthorized extraction. Political interference further weakens water governance. When powerful economic interests influence regulatory decisions, regulatory capture occurs, often resulting in minimal penalties for polluters or preferential water access for large agribusinesses **(Swyngedouw, 2015).** Transboundary governance challenges add complexity. Many international river basins and aquifers lack comprehensive management agreements, and weak enforcement mechanisms enable upstream actors to engage in illegal activities that may be legal in other countries **(Zeitoun et al. 2017).**

Socio-Economic Inequalities: Socio-economic disparities are key drivers of hydro criminality, turning water access into another form of inequality. Marginalized communities, often excluded from formal water systems due to poverty, ethnicity, caste, or remoteness, become vulnerable to exploitation through illegal water markets and unauthorized extraction as survival strategies. In urban areas, informal settlements lack legal recognition and formal water infrastructure. Residents in these areas may pay 5 to 25 times more for water than those connected to municipal systems, as illegal vendors exploit scarcity and regulatory gaps **(Mitlin et al. 2019).** In Mumbai, water mafias control access by tapping into municipal lines, operating through bribes and threats **(Anand, 2017).** Rural-urban divides also fuel hydro criminality. Urban areas prioritize water supply, diverting resources from rural regions, which may lead to criminalized acts of resistance, such as sabotaging pipelines or diverting water, as rural communities defend traditional water use **(Boelens et al. 2019).** Gendered impacts further shape hydro criminality. Women, who are typically responsible for household water provision but have minimal representation in governance, face disproportionate effects. In Kenya's informal settlements, women may be forced to provide sexual favours as payment for water access when unable to afford monetary costs **(Klopp and Petretta, 2017).** Indigenous communities often face water injustice due to legal frameworks that disregard traditional water rights. Colonial-era laws displaced indigenous peoples from their water resources, criminalizing their practices while large corporations extract water legally, damaging watersheds they rely on **(Wilson and Inkster, 2018).** The commodification of water intensifies these inequalities. As water becomes a market good rather than a social necessity, profit-driven motives lead to both legal and illegal exploitation, with marginalized groups resorting to illicit connections or wells to meet basic needs.

Political and Corporate Interests: The intersection of political power and corporate interests fosters hydro criminality by manipulating water governance for private gain. This dynamic, prevalent across various political and economic systems, results in the elite capture of water resources at the expense of public welfare and sustainability. Corporate lobbying plays a significant role in weakening water regulations. Industries reliant on water such as agriculture, mining, and manufacturing invest heavily in shaping policies that benefit them, often resulting in regulatory exemptions or weakened enforcement. Between 2010-2020, U.S. water-intensive industries spent over $1.2 billion on lobbying, leading to rollbacks of Clean Water Act protections **(Corporate Europe Observatory, 2019).** Water privatization also facilitates corporate exploitation. In privatized systems, profit motives often override public service obligations. In Latin America, Africa, and Asia, privatization has led to contract manipulation, unfulfilled commitments, and monopoly exploitation **(McDonald, 2018).** In Cochabamba, Bolivia, privatization saw water prices rise by over 200%, criminalizing community water practices and triggering social unrest. Political corruption in water governance spans both grand corruption in infrastructure projects and petty corruption in service delivery. The OECD estimates corruption raises infrastructure costs by up to 40%, diverting resources from underserved communities **(OECD, 2016).** Local bribery for access points also exacerbates inequality in areas with limited water supply. Elite capture occurs when powerful actors secure preferential access to water through political influence, bypassing formal allocation systems. In California, investigations found that politically connected agricultural operations continued to receive water during droughts while smaller farms faced shortages **(Reisner, 2017).** Regulatory arbitrage allows corporations to exploit weaker enforcement in certain jurisdictions, particularly in transboundary water systems, where pollution from one area impacts another. Finally, the financialization of water, where water rights become investment assets, can incentivize hoarding during scarcity, exacerbating access inequalities **(Loftus et al. 2019).**

IV. Consequences of Hydro Criminality

Human and Public Health Impacts: The health consequences of hydro criminality are most evident through contaminated water supplies, which expose populations to biological and chemical hazards. Illegal industrial discharges of untreated effluents containing heavy metals or toxic chemicals pose persistent health risks, often bypassing municipal treatment systems. The Flint water crisis illustrates how corruption and regulatory failures led to widespread lead exposure, damaging children's neurological health **(Masten et al. 2016).** Biological contamination from illegal sewage discharges presents immediate infectious disease risks. Illicit dumping of untreated waste introduces harmful pathogens into the water, triggering outbreaks. In Jakarta, where 40% of the population lacks proper sanitation, illegal sewage dumping contributes to frequent diarrheal disease outbreaks, disproportionately affecting children under five **(Vollaard et al. 2017).** Agricultural chemical contamination from illegal pesticide use also poses significant health threats. Banned pesticides entering water systems through runoff have been linked to neurological disorders, reproductive health issues, and cancer clusters in India, with pesticide levels exceeding safety thresholds by up to 30 times **(Mathur et al. 2021).** Water theft and infrastructure tampering further compromise health by introducing contaminants into water distribution systems. In Karachi, neighbourhoods with high illegal connection rates had coliform contamination three times higher than secure areas, leading to higher incidences of waterborne diseases **(Ahsan et al. 2019).** Water insecurity due to hydro criminality also drives health problems beyond contamination. When illegal appropriation disrupts the water supply, communities face hygiene challenges, increasing disease transmission. Households with disrupted water access show higher rates of skin infections, eye diseases, and gastrointestinal issues due to inadequate sanitation **(Howard et**

al. 2020). The psychological health impacts of hydro criminality are often overlooked. Chronic water insecurity leads to anxiety, depression, and stress, particularly among women, who typically bear the burden of household water collection. In Chennai's water-scarce neighbourhoods, women reported increased anxiety and sleep disruption linked to water insecurity caused by tanker mafias **(Wutich and Ragsdale, 2018).**

Environmental Degradation: Hydro criminality causes severe and lasting damage to freshwater ecosystems, disrupting biodiversity, ecosystem services, and long-term environmental health. Illegal water extraction and diversion fundamentally alter hydrological systems, often drying up critical waterways. Water mafias or unauthorized agricultural activities can turn perennial rivers into intermittent or dry channels, disrupting ecosystems. The Murray-Darling Basin in Australia illustrates this, where illegal water extraction by large agricultural operations contributed to fish die-offs, with one million fish perishing in 2019 due to low oxygen levels in dried-up pools **(Australian Commission of Water Theft, 2020).** Similarly, illegal diversions in the Colorado River Basin leave parts of the river dry before reaching its delta, harming riparian habitats and species. Unauthorized groundwater extraction accelerates aquifer depletion, leading to long-term environmental damage. In Yemen's Sana'a Basin, illegal drilling causes groundwater tables to drop by 6-8 meters annually, risking complete depletion within decades **(Al-Weshali et al. 2015).** This depletion also causes land subsidence, saltwater intrusion, and loss of aquifer storage capacity. Pollution crimes, such as illegal industrial discharges, devastate aquatic life. Factories in China's Pearl River Delta have been found releasing untreated effluents containing heavy metals like chromium and cadmium, which accumulate in aquatic food chains and create "dead zones" where oxygen depletion makes waters uninhabitable **(Zhang et al. 2019).** Wetland destruction often results from illegal drainage, filling, or pollution. Despite legal protections, wetlands in the U.S. have been encroached upon, with developers conducting unauthorized activities under the radar to avoid detection **(EPA Enforcement Actions, 2018).** Thermal pollution from industrial cooling water discharges also threatens aquatic ecosystems. In Eastern Europe, factories have been found releasing water at temperatures up to 15°C above legal limits, disrupting aquatic habitats and causing algal blooms **(European Environmental Bureau, 2017).**

Socio-Economic Impacts: The socio-economic impacts of hydro criminality extend beyond water access, undermining livelihoods, exacerbating poverty, and damaging economic productivity across sectors. Agricultural communities suffer when illegal water theft or pollution affects irrigation. In Pakistan's Indus Basin, illegal diversions by politically connected landowners reduce crop yields by up to 70%, forcing smallholder farmers into debt and landlessness **(Mustafa et al. 2021).** These impacts extend to rural economies, affecting agricultural labourers and suppliers. Fishing communities also face existential threats from pollution crimes that destroy aquatic habitats. In Indonesia's Citarum River, illegal textile factory discharges eliminated 60% of fish species and made the remaining fish toxic, causing a loss of $100 million annually for 30,000 fishers **(Greenpeace, 2018).** Pastoralist communities dependent on water for livestock are particularly vulnerable. Unauthorized diversions in Ethiopia's Awash River Basin, caused by commercial sugar plantations, reduced water access for 50,000 pastoralists, forcing livestock sales and increasing dependence on aid **(Müller-Mahn et al. 2021).** Tourism economies suffer when hydro criminality degrades environmental quality. In Mexico's Riviera Maya, illegal sewage discharges linked to resorts caused algal blooms, coral reef damage, and beach closures, resulting in $100 million in lost tourism revenue **(Hernandez-Terrones et al. 2015).** Water contamination also reduces property values. Groundwater contamination can decrease property values by 15-30%, disproportionately affecting marginalized communities near polluting industries **(Guignet et al. 2018).** This devaluation further reduces municipal tax bases, hindering public service provision. Public health costs of hydro criminality create substantial economic burdens through increased healthcare expenditures, lost productivity, and premature mortality. Industrial discharges of carcinogens into water supplies lead to elevated disease rates, with costs often borne by public health systems and affected families.

Conflict and Insecurity: Water-related conflicts are increasingly driven by hydro criminality, spanning from local violence to international tensions. As water becomes scarcer, criminal control over water resources creates significant security challenges, impacting human safety, political stability, and regional peace. At the local level, water mafias in urban areas use violence to maintain control over illegal distribution networks. In Delhi, criminal syndicates control illegal connections and tanker deliveries, using intimidation and violence against residents. Over 200 violent incidents related to water control were documented between 2016-2020, including assaults and killings of community activists **(Mehta, 2020).** A similar situation occurs in Karachi, where criminal organizations fight for water distribution control, turning access into a political and economic weapon. Rural water conflicts often arise from upstream theft or diversion, depriving downstream communities of water for agriculture. In Yemen's highlands, over 600 violent disputes were reported between 2015 and 2019 over unauthorized groundwater extraction, often involving armed confrontations between villages **(Al-Dawsari, 2021).** These conflicts usually pit marginalized communities against powerful landowners with political influence. Infrastructure sabotage has become a common form of resistance, especially when communities perceive corruption in water allocation. In South Africa, over 140 incidents of damage to water infrastructure occurred between 2017-2020, mainly in areas where residents felt agricultural or mining interests received preferential access **(Schreiner and Hassan, 2019).** Transboundary tensions arise when upstream nations exploit

governance gaps in shared water systems. In the Nile Basin, Ethiopia's Grand Renaissance Dam project prompted accusations of water theft from Egypt, leading to military threats and international diplomatic interventions **(Zeitoun et al. 2019).** In conflict zones, criminal organizations use water access as a commodity, deliberately creating scarcity to extract profit. In Syria, armed groups controlled water infrastructure to manipulate civilian access and generate revenue **(von Lossow, 2020).** Climate change exacerbates these conflicts by reducing water availability and increasing the likelihood of violence when governance is corrupted. Regions with captured water governance systems are more prone to violent conflict than those with transparent, equitable management **(Schleussner et al. 2016).**

V. Legal Frameworks

National Laws and Regulatory Gaps: National water laws **(Table 1)** vary widely, shaped by legal traditions, hydrological conditions, and governance priorities. Despite these differences, common regulatory gaps and implementation challenges create vulnerabilities that enable hydro criminality. Identifying these gaps reveals structural weaknesses that criminals exploit to misuse water resources. Water rights regimes, a core component of national water law, often contain ambiguities that facilitate illegal appropriation. Many countries use hybrid systems combining riparian rights, prior appropriation, state ownership, and indigenous rights, creating jurisdictional confusion. In India, for example, the colonial-era principle that land ownership grants unlimited extraction rights enables widespread unauthorized groundwater exploitation **(Cullet et al. 2019).** This has led to over 20 million illegal wells depleting aquifers nationwide. Permitting and licensing systems also contain loopholes that allow illegal water use. Exemptions for small or domestic users can cover substantial unauthorized extraction. California's previous lack of regulation on groundwater pumping, until the 2014 Sustainable Groundwater Management Act, contributed to significant overdraft conditions **(Kiparsky et al. 2017).** Other regions continue to maintain outdated exemptions, despite changed hydrological realities. Limited monitoring and enforcement capacity is a major factor enabling hydro criminality. Even comprehensive water laws fail without proper implementation. The Flint water crisis highlighted this, where enforcement failures allowed lead contamination to persist despite federal regulations, with officials falsifying compliance reports **(Butler et al. 2016).** Economically disadvantaged communities are most affected by these enforcement gaps. Penalties for water crimes often lack deterrent effects, as they are minor compared to the economic gains from violations. In the U.S., industrial water pollution penalties are typically less than 0.2% of corporate violators' annual revenues, reducing their effectiveness as deterrents **(EPA Enforcement Analysis, 2020).** Transboundary water governance within federal systems adds complexity. When water flows across state or provincial boundaries, jurisdictional conflicts create enforcement vacuums. The Murray-Darling Basin scandal in Australia, where upstream theft caused significant downstream damage, illustrates the difficulty of coordinating enforcement across regions **(Australian Commission of Water Theft, 2020).** Emerging water challenges, like climate change, hydraulic fracturing, and water financialization, highlight additional regulatory gaps. Many legal systems have not yet adequately addressed these issues, creating grey areas where activities may remain technically legal despite significant harm to water resources and communities.

International Water Law: International water law offers a framework for addressing transboundary hydro criminality, but its effectiveness is constrained by significant limitations. The development of international water law includes customary principles, bilateral agreements, regional frameworks, and global conventions, creating a complex and varied legal landscape. The **UN Watercourses Convention (1997)** is the most comprehensive global framework, establishing principles such as equitable utilization, prevention of harm, and notification obligations.

Table 1
Water Laws and Acts by Country

S.No.	Country	Acts
1	India	Water (Prevention and Control of Pollution) Act, 1974; The Water (Prevention and Control of Pollution) Cess Act, 1977; Environment Protection Act, 1986; National Water Policy, 2012; The Easements Act, 1882; Interstate River Water Disputes Act, 1956; River Boards Act, 1956; The Ground Water (Management and Regulation) Bill, 2017
2	United States	Clean Water Act (1972); Safe Drinking Water Act (1974); Water Quality Act (1987); Coastal Zone Management Act (1972); Federal Water Pollution Control Act (1948); Water Resources Development Act (various years); State-specific water laws (e.g., California Water Code)
3	Australia	Water Act 2007; Water Amendment Act 2008; National Water Initiative 2004; Murray-Darling Basin Plan 2012; Environment Protection and Biodiversity Conservation Act 1999; State-specific Water Management Acts
4	South Africa	National Water Act 36 of 1998; Water Services Act 108 of 1997; National Environmental Management Act 107 of 1998; Water Research Act 34 of 1971
5	Brazil	National Water Resources Policy (Law 9.433/1997); National Environmental Policy (Law 6.938/1981); Forest Code (Law 12.651/2012); National Basic Sanitation Law (Law 11.445/2007)

6	China	Water Law of the People's Republic of China (2016 revision); Water Pollution Prevention and Control Law (2017); Environmental Protection Law (2014); Water and Soil Conservation Law (2010)
7	European Union	EU Water Framework Directive (2000/60/EC); Groundwater Directive (2006/118/EC); Drinking Water Directive (98/83/EC); Floods Directive (2007/60/EC); Urban Waste Water Treatment Directive (91/271/EEC)
8	Mexico	National Water Law (1992, amended 2004); General Law of Ecological Balance and Environmental Protection (1988); Federal Rights Law (regarding water fees)
9	Kenya	Water Act 2016; Environmental Management and Coordination Act 1999; Irrigation Act 2019; Water Services Regulations 2012
10	Japan	Basic Act on Water Cycle (2014); Water Pollution Control Law (1970); River Act (1997); Sewerage Service Act (1958); Act on Special Measures for Water Quality Conservation at Water Resources Area (1994)
11	Singapore	Public Utilities Act (2002); Environmental Protection and Management Act (2002); Sewerage and Drainage Act (1999); Public Utilities (Water Supply) Regulations
12	Germany	Federal Water Act (Wasserhaushaltsgesetz); Waste Water Charges Act (Abwasserabgabengesetz); Drinking Water Ordinance (Trinkwasserverordnung); State Water Laws (Landeswassergesetze)
13	Canada	Canada Water Act (1985); Canadian Environmental Protection Act (1999); Fisheries Act; International River Improvements Act; Provincial water acts (e.g., British Columbia Water Sustainability Act)
14	Israel	Water Law (1959); Water and Sewage Corporations Law (2001); Streams and Springs Authorities Law (1965); Water Regulations (Prevention of Water Pollution) (1997)
15	Thailand	National Water Resources Act (2018); Enhancement and Conservation of National Environmental Quality Act (1992); Groundwater Act (1977, amended 2003); Royal Irrigation Act (1942, amended 1975)
16	Nigeria	Water Resources Act (1993/2004); Environmental Impact Assessment Act (1992); River Basin Development Authority Act; National Environmental Standards and Regulations Enforcement Agency Act (2007)
17	Chile	Water Code (1981, amended 2005); Environmental Framework Law (1994); Law 21.064 (2018); DFL 1122 (on water rights and trading)
18	Malaysia	Water Services Industry Act (2006); National Water Services Commission Act (2006); Environmental Quality Act (1974); National Resources and Environment Ordinance (Sarawak)
19	Philippines	Clean Water Act (2004); Water Code of the Philippines (1976); Ecological Solid Waste Management Act (2000); Local Government Code (1991)

Sources: Compiled from different countries' acts/laws

However, it entered into force only in 2014 and has been ratified by just 37 countries, with key actors like China, India, and most Nile Basin states not participating, weakening its effectiveness in preventing upstream pollution or diversion **(Salman, 2015).** The **Helsinki Rules (1966)** laid the foundation for transboundary water management by introducing the concept of reasonable and equitable utilization, but they lack binding legal status. The **Berlin Rules (2004)** modernized these principles, incorporating environmental protection and public participation, but also lacked enforcement authority **(Dellapenna, 2007).** Regional frameworks offer more specific governance structures, with varying effectiveness. The European Union's Water Framework Directive has strong standards and enforcement mechanisms, while the Mekong River Commission struggles due to China's limited participation **(Zeitoun et al. 2019).** Bilateral treaties are the most common transboundary agreements, with over 400 worldwide. The Indus Waters Treaty between India and Pakistan is a relatively successful example, maintaining water allocation despite political tensions through institutional mechanisms **(Zawahri, 2019).** The main challenge for international water law is enforcement limitations. Unlike domestic legal systems, international frameworks lack independent monitoring, policing authority, or compulsory jurisdiction. Violations often result in diplomatic protests or voluntary dispute resolution, which requires mutual consent. Substantive gaps further limit effectiveness, particularly in groundwater governance. The Draft Articles on Transboundary Aquifers (2008) remain unadopted, leaving shared aquifers largely unregulated, despite their critical importance for irrigation and freshwater supply **(Eckstein, 2017).** Climate change exacerbates challenges by shifting precipitation patterns and retreating glaciers, potentially making historical water agreements misaligned with current realities. This could incentivize unilateral actions that would be considered hydro crimes domestically but exploit international legal ambiguities.

Environmental and Criminal Law Overlaps: The intersection of environmental and criminal law creates a complex regulatory landscape for addressing hydro criminality. As environmental harm has gained greater recognition, there has been a shift toward criminalizing water-related offences, presenting both opportunities and challenges for prosecution. Criminal provisions within environmental laws vary across jurisdictions. In the U.S., the Clean Water Act imposes criminal penalties for knowing violations, including up to 15 years imprisonment for endangering public health. However, proving intent in complex organizational settings can be difficult **(Uhlmann, 2016).** Brazil's laws, by contrast, impose strict liability for certain offences, eliminating the need to prove intent for basic violations, while reserving harsher penalties for intentional acts **(Amorim, 2015).** Corporate criminal liability is a significant challenge in prosecuting hydro crimes, especially within organizations. Some legal systems limit prosecution to individual decision-

makers, while others hold corporations accountable through vicarious responsibility or organizational fault based on corporate culture **(Pieth and Ivory, 2019).** Sentencing for hydro crimes reveals tensions between criminal law and environmental protection goals. Traditional sentencing focuses on imprisonment and fines, but environmental harm often requires restoration and remediation. Some jurisdictions have adopted innovative sentencing, including environmental restoration projects and compliance programs, such as the EU's Environmental Crime Directive, which encourages restoration-oriented penalties **(Faure, 2017).** Prosecutorial expertise is a barrier, as traditional criminal prosecutors often lack knowledge of hydrology and environmental science. Specialized environmental units have been created in some areas, but resource constraints hinder their widespread availability, particularly in lower-income countries where hydro criminality is prevalent **(UNEP, 2018).** Transnational environmental crime presents additional challenges. Pollution across borders complicates prosecution, as jurisdictional barriers hinder evidence collection, witness testimony, and enforcement. International legal assistance treaties offer some support, but procedural hurdles remain **(White, 2018).** Emerging models of ecocide law, which aim to prosecute severe environmental crimes like hydro criminality as international crimes, offer the potential for strengthening accountability. While still largely aspirational, these frameworks could provide new pathways for addressing the most serious water crimes **(Higgins, 2019).**

VI. Policy Strategies and Governance Solutions

Strengthening Legal Accountability: Effective legal accountability for hydro criminality requires systemic reforms to address the identification, prosecution, and deterrence of water crimes. These reforms must close substantive legal gaps and overcome procedural barriers that limit accountability for illegal water appropriation, pollution, and mismanagement. Criminalizing specific water offences is crucial. Many jurisdictions have general environmental protections, but explicitly defining water crimes helps with enforcement. South Africa's National Water Act provides a clear model, criminalizing water theft, unauthorized use, and infrastructure interference, with penalties that include fines and imprisonment **(Schreiner and Hassan, 2017).** India's 2020 Dam Safety Act similarly criminalizes dam interference, addressing issues of manipulation for private irrigation. Specialized environmental crime units are key for effective prosecution. Brazil's environmental prosecutors, trained in science and forensic evidence, have achieved higher conviction rates for water crimes than jurisdictions with general prosecutors **(Amorim, 2019).** These units excel in tracking pollution, documenting groundwater impacts, and linking corporate actions to environmental harm. Enhanced penalties linked to the economic benefits of violations improve deterrence. Fixed fines often don't deter corporate offenders, so percentage-of-revenue penalties are more effective. For instance, Australia's Water Act amendments impose penalties of up to 20% of annual revenue for water theft, dramatically shifting risk calculations **(Australian Water Amendment Act, 2018).** Whistleblower protections support internal reporting of water crimes. Given the technical nature of hydro crimes, employees with insider knowledge are crucial for uncovering violations. The EU's Whistleblower Protection Directive offers a model, requiring protected disclosure channels and confidentiality during investigations **(EU Directive 2019/1937).** Advanced surveillance technologies enable better detection, especially in remote areas. Satellite monitoring, combined with machine learning, can identify unauthorized irrigation and pollution, enhancing enforcement. India's Central Ground Water Authority used satellite monitoring to detect unauthorized borewells, increasing violation detection by 300% **(Gandhi and Sarkar, 2021).** Criminal asset forfeiture mechanisms enhance accountability by allowing authorities to seize assets derived from water crimes. This is particularly effective against organized crime. Italy's use of anti-mafia asset seizure laws against illegal water extraction for high-value crops led to a 60% drop in violations in targeted regions **(European Environmental Agency, 2020).**

Community-Based Water Governance: Community-based water governance offers an alternative to centralized systems vulnerable to criminal exploitation by involving local stakeholders in resource management. These approaches leverage local knowledge, ensure transparency, and establish collective responsibility, reducing hydro criminality by addressing information asymmetries and enforcement gaps. Water user associations (WUAs) are a widespread model for community governance, where stakeholders manage shared resources. In Mexico, over 500 WUAs now manage 3.4 million hectares, reducing water theft and system tampering compared to previous centralized systems **(Garces-Restrepo et al. 2018).** These associations create social pressure against excessive extraction by making water use visible and establishing conflict resolution mechanisms. Indigenous governance systems integrate cultural values and traditional ecological knowledge to sustain equitable water allocation. New Zealand's recognition of the Whanganui River as a living entity, with co-governance between Māori communities and government agencies, exemplifies this approach **(Macpherson and Ospina, 2020).** This model emphasizes responsibilities over extractive rights. Participatory monitoring programs enhance community capacity to detect water crimes. In Ecuador, Indigenous guardian programs identified illegal mercury discharges in mining regions, providing evidence that supported prosecutions **(Bebbington et al. 2018).** These programs extend monitoring beyond the reach of centralized agencies. Legal frameworks recognizing collective rights protect community-managed systems from external exploitation. Mexico's protection of ejido water rights and Bolivia's constitutional recognition of community water systems safeguard local authority from private market encroachment **(Boelens et al. 2019).** Technology-supported community governance merges local knowledge with digital tools. Spain's SmartH2O platform, using mobile apps and remote sensing data,

increased the detection of illegal irrigation by over 200% compared to traditional methods **(Novak et al. 2018).** Scaling these approaches, especially for transboundary watersheds, remains a challenge. However, nested institutional arrangements, such as those in the Nile Basin Initiative, can connect local governance to broader regional frameworks, though challenges remain in achieving transboundary accountability **(Cascão and Nicol, 2016).**

Public Participation and Transparency: Public participation and transparency are vital for combating hydro criminality by shedding light on opaque decision-making, increasing accountability, and reducing corruption in water governance. Enhancing visibility in areas such as water allocation, quality monitoring, and infrastructure development empowers citizens to detect and challenge water-related crimes **(Campos and Melo, 2020; Schreiner and Hassan, 2017).** Open data initiatives play a transformative role by making critical information like extraction permits, pollution data, and compliance records publicly accessible. Platforms like Portugal's SNIRH provide real-time data on river flows and water quality, while Chile's SISS portal allows tracking of industrial discharge and violations, thereby strengthening citizen oversight **(Campos and Melo, 2020).** Participatory decision-making ensures inclusive governance by integrating community voices in water allocation and project planning. South Africa's Catchment Management Agencies, for example, include diverse stakeholder representation, helping prevent capture by elite interests **(Schreiner and Hassan, 2017).** Transparent budgeting and monitoring systems, such as India's DISHA platform, allow citizens to track rural water project expenditures, reducing embezzlement and contractor favouritism through public scrutiny **(Government of India, 2020).**

VII. Case Studies

This section highlights examples of water-related criminality in various regions, showing how socio-political and economic contexts shape hydro-criminality.

India: In Chennai, the "tanker mafia" exploits water scarcity by controlling distribution, creating artificial shortages, and charging high prices. This criminal syndicate colludes with officials and targets vulnerable communities with contaminated water **(Srinivasan, 2022).** The Yamuna River faces industrial pollution from untreated effluents despite court interventions, reflecting regulatory capture and enforcement failures **(Agarwal and Singh, 2023).** Corruption drives these water crimes, with marginalized communities bearing the brunt of both quality and access issues **(Mehta and Karpouzoglou, 2021).**

South Africa: Agricultural water theft is a major issue, with large commercial farms illegally extracting water from rivers and aquifers, particularly in the Western Cape and Limpopo **(Jacobs and Meissner, 2023).** This theft undermines efforts for equitable distribution, with corruption and regulatory gaps enabling it. Small-scale farmers and rural communities suffer as water resources are diverted upstream **(Schreiner and van Koppen, 2021).**

United States: The Flint water crisis illustrates state negligence and environmental injustice. In 2014, officials failed to apply corrosion inhibitors after switching water sources, leading to lead contamination in a predominantly African American community **(Hanna-Attisha et al. 2022).** Despite early warnings, authorities concealed risks and falsified reports, showing how regulatory capture enables hydro-criminality **(Campbell et al. 2021).** Marginalized communities faced disproportionate harm and delayed remediation **(Pauli, 2023).**

Middle East: Water is used as both a weapon and a strategic tool in Middle Eastern conflicts. Militants in Syria and Iraq target water infrastructure, while state actors manipulate water flow through dams for geopolitical leverage, especially in the Tigris-Euphrates basin **(Zeitoun et al. 2022).** These practices violate international humanitarian law and exacerbate civilian suffering. Additionally, discriminatory policies restrict Palestinian access to aquifers in the West Bank **(Weinthal and Sowers, 2021).**

Latin America: Anti-privatization protests across Latin America showcase resistance to water commodification. The Cochabamba Water War of 2000 in Bolivia saw successful civil opposition to privatization, which increased water tariffs and criminalized traditional rainwater collection **(Romano and Díaz, 2022).** Similar conflicts in Chile have arisen over water allocation favouring corporations, with activists facing criminalization and violence from state and corporate forces **(McNeish, 2021).** These cases highlight the tension between neoliberal governance and communal water rights, with criminal law used to suppress alternative water management models **(Bauer, 2021).**

VIII. Notable Water Crimes Cases and Judgments in India

Supreme Court of India

- ✓ M.C. Mehta v. Union of India (1988)**:** In this landmark judgment addressing the pollution of the Ganges River, the Supreme Court directed tanneries to establish effluent treatment plants or face closure. The Court affirmed that the right to clean water is intrinsic to the right to life under Article 21 of the Constitution **(Divan and Rosencranz, 2021).**
- ✓ Indian Council for Enviro-Legal Action v. Union of India (1996)**:** Known as the "Bichhri case," this ruling held chemical industries accountable for severe groundwater contamination. The Court enforced the "polluter pays" principle, ordering the responsible parties to bear the cost of environmental remediation **(Sahu, 2018).**
- ✓ Vellore Citizens Welfare Forum v. Union of India (1996)**:** This judgment condemned pollution by tanneries in Tamil Nadu and introduced key environmental principles into Indian jurisprudence namely sustainable development, the precautionary principle, and the polluter pays principle **(Gill, 2017).**
- ✓ M.C. Mehta v. Kamal Nath (1997)**:** The Supreme Court invoked the public trust doctrine, emphasizing that natural resources like rivers, forests, and air cannot be subject to private ownership and must be preserved for public benefit **(Cullet and Koonan, 2019).**

High Courts

- ✓ Perumatty Grama Panchayat v. State of Kerala (2003)**:** The Kerala High Court ruled against Coca-Cola's over-extraction of groundwater, declaring that underground water is a public resource and imposing limits on its commercial exploitation **(Philippe, 2020).**
- ✓ Narmada Bachao Andolan v. Union of India (2000)**:** While allowing the construction of the Narmada dam to proceed, the Supreme Court mandated robust rehabilitation for displaced populations and enforced environmental safeguards to protect river water quality **(Nariman, 2019).**
- ✓ Delhi Jal Board v. National Campaign for Dignity and Rights of Sewerage and Allied Workers (2011)**:** The Delhi High Court addressed the unsafe working conditions of sewage workers, linking water governance with human rights and the dignity of sanitation labourers **(Chaplin, 2017).**
- ✓ K.R. Thankappan v. Secretary to Government (2019)**:** In this case, the Kerala High Court held that intentional industrial pollution of water bodies constitutes a violation of the fundamental right to life and amounts to criminal negligence **(Iyer, 2022).**

Collectively, these judicial decisions have played a pivotal role in shaping India's legal and institutional frameworks around water governance. They establish the right to clean water as a fundamental right, reinforce the public trust doctrine, and promote key environmental principles such as the polluter pays and precautionary principles. These rulings have significantly contributed to the enforcement of laws against water-related crimes while promoting sustainable management and the protection of vulnerable communities.

IX. Conclusion

Hydro criminality poses a growing threat to water security, environmental sustainability, and social justice in the Anthropocene. Crimes such as water theft, pollution, corruption, and violence arise from intertwined environmental, institutional, social, and political drivers. Climate change and resource depletion foster conditions ripe for exploitation, while weak governance enables such crimes to flourish. Marginalized communities are often forced into criminalized survival strategies, whereas powerful actors manipulate systems for gain. The impacts of hydro criminality go beyond water management, threatening public health, ecosystems, and social stability. Contaminated water leads to widespread disease, environmental degradation disrupts ecosystem services, and socioeconomic damage disproportionately harms vulnerable populations. These dynamics heighten the risk of violent conflict, both locally and across regions. Legal frameworks remain fragmented and under-resourced. National laws often appear strong on paper but lack enforcement, while international water law is hindered by sovereignty concerns and voluntary compliance. The overlap between environmental and criminal law lacks specialized tools and innovative strategies to effectively address water crimes. Case studies from various regions reveal consistent patterns: regulatory capture, inequality, marginalized communities bearing disproportionate burdens, and powerful interests exploiting legal loopholes. India's judiciary offers a model by recognizing water as a fundamental right and public trust, though practical enforcement remains uneven. Combating hydro criminality requires a multifaceted approach. Legal reforms should include the explicit criminalization of water offences, the creation of specialized enforcement and prosecution units, and the use of technology for monitoring. Community-based governance should be strengthened to incorporate local oversight and traditional knowledge. Transparency initiatives are vital to exposing corruption and enabling civic monitoring. Solutions must address both the criminal acts and underlying systemic drivers. This includes enhancing institutional coordination, recognizing traditional water rights, reducing inequalities, and limiting corporate-political interference in water governance. Aligning national

laws, fostering international cooperation, developing specialized legal capacities, and holding corporate actors accountable are all critical. The most effective governance connects local, national, and international levels, tailored to regional contexts but grounded in shared values of transparency, equity, and accountability. As water scarcity intensifies, such integrated strategies become essential to ensuring equitable access, protecting ecosystems, and securing water for future generations.

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