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Post-Soviet Environmental Governance: Institutional Gaps and Policy 1 Failures in  
Central Asia 2 Abstract 3 The dissolution of the Soviet Union marked a critical turning point  
in environmental 4 governance across Central Asia. This paper examines how post-Soviet  
institutional 5 fragmentation, weak regulatory frameworks, and uneven policy transitions  
have contributed 6 to persistent environmental degradation in Central Asia. The region -  
situated between the 7 Amu Darya and Syr Darya river basins and bordered by the  
Caspian Sea and the shrinking 8 Aral Sea - possesses abundant yet unevenly distributed  
natural resources, including 9 hydrocarbons, minerals, and glacial freshwater reserves.  
However, water has emerged as the 10 most conflict-prone and strategically significant  
resource. Soviet-era ecological exploitation, 11 particularly unsustainable irrigation and  
monoculture practices, laid the foundation for 12 contemporary crises. In the post-  
independence period, institutional gaps, limited regional 13 coordination, and governance  
deficits have hindered effective environmental protection and 14 climate adaptation. 15  
Climate change intensifies these vulnerabilities through glacier retreat, desertification, 16  
declining agricultural productivity, and worsening public health outcomes. The pollution of  
17 the Caspian Sea and the near-collapse of the Aral Sea exemplify policy failures and  
weak 18 enforcement mechanisms. This study argues that environmental degradation in  
Central Asia 19 is not merely an ecological issue but a multidimensional security challenge  
shaped by 20 governance weaknesses and fragmented regional cooperation. By analysing  
institutional 21 structures, policy implementation gaps, and regional dynamics, the paper  
situates Central 22 Asia within broader debates on environmental security and post-  
socialist governance 23 transitions, offering pathways toward integrated and resilient  
environmental governance. 24 Keywords: Central Asia; Environmental Governance; Post-  
Soviet Transition; Water 25 Security; Climate Change; Institutional Gaps 26 27 28  
Introduction 29

Central Asia occupies a distinctive geopolitical and ecological space, marked by abundant  
yet 30 unevenly distributed natural resources(Kumar D. H., 2015). Stretching between the

Amu Darya and Syr Darya river systems and bordered by the Caspian Sea and the Aral Sea, the region is predominantly arid and semi-arid, where water constitutes the most critical and contested resource. Despite vast reserves of hydrocarbons - particularly in Kazakhstan, Turkmenistan, and Uzbekistan - freshwater scarcity defines the environmental reality of the region. In countries such as Kazakhstan, water withdrawal rates have surpassed 40 percent of available supplies, indicating acute water stress. Meanwhile, Kyrgyzstan and Tajikistan depend heavily on glacier-fed water sources, which are increasingly vulnerable to climate change. The ecological fragility of Central Asia is inseparable from its historical political economy. During the Soviet era, centralized agricultural planning converted the region into a major cotton-producing zone through extensive irrigation projects. This model, especially dominant in Uzbekistan and Turkmenistan, prioritized output over sustainability and dramatically altered natural hydrological systems. The diversion of the Amu Darya and Syr Darya rivers for irrigation stands as the most consequential example of this transformation. Prior to the 1960s, approximately 55 billion cubic meters of water flowed annually into the Aral Sea; by 2000, this figure had fallen to roughly 1.5 billion cubic meters. The result was one of the gravest ecological disasters of the twentieth century: the Aral Sea shrank to nearly a quarter of its original size, devastating surrounding ecosystems and livelihoods (Kumar, 2021, p. 91). Regions such as Karakalpakstan in Uzbekistan witnessed rising mortality rates, declining life expectancy, and widespread public health crises linked to environmental degradation. The environmental consequences inherited at independence in 1991 were profound. The newly sovereign republics - Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan - emerged from the Soviet collapse with degraded ecosystems, aging infrastructure, and fragmented governance mechanisms ill-suited for cooperative water management. Although political authority largely remained in the hands of former Soviet-era elites, the institutional framework that had previously coordinated resource allocation across republics disintegrated (Kumar, H., 2024, p. 2). This created significant governance gaps,

particularly in transboundary water management, where upstream and downstream interests 59 often diverged. 60

Environmental degradation in Central Asia extends beyond ecological loss; it intersects 61 directly with human security, economic stability, and regional politics. Water disputes, energy 62 dependence, migration flows, and food insecurity illustrate the multidimensional nature of 63 environmental challenges. In desert and semi-desert contexts, where water is indispensable 64 for agricultural survival, scarcity carries immediate socio-economic implications. The Aral 65 Sea crisis further exemplifies how environmental mismanagement can generate long-term 66 health emergencies, including respiratory illnesses, contaminated water supplies, and 67 declining agricultural productivity. Moreover, climate change has intensified existing 68 vulnerabilities. Melting glaciers in the mountainous upstream states threaten long-term water 69 availability, while rising temperatures accelerate desertification and soil salinization. The 70 heavily polluted Caspian Sea adds another layer of environmental concern, particularly given 71 the expansion of hydrocarbon extraction. 72 Following the dissolution of the Soviet Union, the region also attracted renewed international 73 attention due to its strategic location and substantial oil and gas reserves (Kumar D. H., 2023, 74 p. 115). However, resource wealth has not translated into effective environmental 75 governance. Instead, institutional fragmentation, limited regional cooperation, and competing 76 national priorities have constrained sustainable policy responses. 77 In this context, post-Soviet environmental governance in Central Asia must be understood as 78 a complex interplay of historical legacies, institutional weaknesses, and emerging climate 79 pressures. The environmental crisis confronting the region is not merely a matter of 80 ecological decline; it represents a structural challenge rooted in governance deficits and 81 policy failures that continue to shape the trajectory of sustainable development in Central 82 Asia. 83 Review of Literature 84 The concept of environmental security brings together two deeply contested and analytically 85 complex notions - security and environment. Because both terms carry

diverse meanings<sup>86</sup> across disciplines, their convergence has generated extensive debate and multiple<sup>87</sup> interpretations (Matthew, A. Richard et al, 2010, p. 5). The interaction between ecological<sup>88</sup> change and questions of safety, survival, and stability has therefore emerged as a significant<sup>89</sup> area of scholarly inquiry. Historically, concerns regarding the relationship among population<sup>90</sup> growth, environmental degradation, and conflict can be traced back to early political<sup>91</sup> economy. In his essay on the Principle of Population, Thomas Malthus argued that “the<sup>92</sup>

power of population is indefinitely greater than the power of the earth to produce subsistence<sup>93</sup> for man.” He maintained that the imbalance between food supply and demographic expansion<sup>94</sup> would inevitably result in famine, disease, and war. More than a century later, Fairfield<sup>95</sup> Osborn revived similar anxieties by questioning when it would be acknowledged that<sup>96</sup> aggressive national policies and international discord could be linked to diminishing<sup>97</sup> productive land and rising population pressures. Such reflections laid the intellectual<sup>98</sup> foundation for later debates connecting environmental stress to instability. By the 1960s,<sup>99</sup> environmental degradation had become a visible global concern, and scholars increasingly<sup>100</sup> examined its political and social consequences. Rachel Carson’s *Silent Spring* (1962) marked<sup>101</sup> a turning point by drawing attention to the destructive effects of pollution and catalysing<sup>102</sup> environmental movements worldwide. Although environmental awareness gained momentum<sup>103</sup> during this period, the systematic linkage between environmental change and violent conflict<sup>104</sup> entered mainstream security studies only toward the end of the Cold War. In 1989, nearly ten<sup>105</sup> academic articles addressing this connection were published, signalling a significant shift in<sup>106</sup> the discipline (O’ Tuathail, 1996). These developments collectively elevated environmental<sup>107</sup> change from a scientific concern to a matter of political and societal security. <sup>108</sup> Conceptually, the term “environment” commonly refers to the “natural environment,”<sup>109</sup> encompassing all components, conditions, and factors that influence the growth and <sup>110</sup> development of living organisms (Yadav, Alok, 2013). The relationship

between ecological 111 protection and human security involves both normative and practical dimensions, as 112 environmental deterioration directly affects livelihoods, health, and social stability. This 113 interdependence is particularly visible in Central Asia, where environmental challenges are 114 multidimensional and deeply intertwined with socio-economic and political dynamics. 115 Among the most pressing concerns in the region are water scarcity, radiation hazards, and 116 waste management, each posing serious threats to human security. 117 The most widely cited example of environmental mismanagement in Central Asia is the Aral 118 Sea crisis. Over the past half-century, the Aral Sea has shrunk dramatically, leading to severe 119 ecological, social, economic, and public health consequences (Oral, 2003, p. 5).The 120 desiccation resulted primarily from the diversion of rivers to support the Soviet Union's 121 cotton cultivation strategy. Covering approximately 68,000 square kilometers in 1960, the sea 122 had reduced to a fraction of its original size by the mid-1990s and was nearing ecological 123 collapse by 2000. The degradation of this once-vast water body exemplifies how state-driven 124

development policies, when detached from ecological considerations, can generate long-term 125 regional instability. 126 In response to escalating environmental vulnerabilities, Central Asian states have begun 127 formulating adaptation and mitigation strategies, particularly in relation to climate change. 128 National policies increasingly emphasize water resource management, renewable energy 129 development, and energy efficiency. Kazakhstan, for instance, has set targets to expand its 130 renewable energy capacity(UNDP Kazakh, 2023), while Uzbekistan is undertaking reforms to 131 modernize its energy sector and reduce carbon emissions(Dimovska, 2023). These initiatives 132 reflect growing recognition of climate-related risks and the need for sustainable development 133 pathways. 134 Regional cooperation has also become central to addressing shared environmental challenges, 135 especially in managing transboundary water resources critical to regional stability. 136 International organizations such as UNDP and ADB are actively supporting adaptation and 137 mitigation projects aimed at

strengthening institutional capacity and fostering resilience. 138 Moreover, Central Asian countries have demonstrated commitment to global climate 139 governance frameworks. Kazakhstan signed and ratified the Paris Agreement on August 2, 140 2016, and December 6, 2016, respectively(OECD, 2016), underscoring the region's 141 engagement with international climate commitments. In addition to state and multilateral 142 initiatives, several NGOs and INGOs - including the Aga Khan Foundation, Asian 143 Development Bank, CARE International, Central Asian Climate Information Platform, ECO 144 Forum of NGOs of Kazakhstan, International Union for Conservation of Nature, the German 145 Corporation for International Cooperation, Oxfam, and the Regional Environmental Centre 146 for Central Asia - play an instrumental role in advancing environmental awareness, capacity147 building, and policy implementation across the region. Collectively, the literature underscores 148 that environmental governance in Central Asia remains closely linked to broader questions of 149 institutional capacity, regional cooperation, and human security. 150 151 Although substantial scholarship exists on post-Soviet environmental governance, important 152 analytical gaps remain. In particular, limited attention has been paid to examining 153 institutional deficiencies and policy failures in the specific context of Central Asian states. 154 While individual country-based studies are available, there is a noticeable shortage of 155 comparative research exploring how these states interact and address shared environmental 156

challenges collectively. The absence of a region-wide, comparative framework highlights the 157 need for focused research to bridge these gaps and strengthen understanding of governance 158 dynamics in Central Asia. 159 Research Questions 160 1. How did the Soviet environmental legacy shape post-independence governance 161 structures? 162 2. What institutional gaps hinder effective environmental policy implementation? 163 3. How does environmental degradation intersect with regional security and conflict 164 risks? 165 Hypothesis 166 Weak institutional coordination and fragmented policy frameworks in post-Soviet Central 167 Asia have exacerbated environmental degradation and heightened

environmental security 168 risks. 169 Research Methodology 170 This study adopts a mixed-methods research design combining quantitative and qualitative 171 approaches to examine institutional gaps and policy failures in post-Soviet environmental 172 governance in Central Asia. The quantitative component draws on official environmental 173 statistics, national legislation, and policy documents from the Central Asian states to identify 174 trends in water stress, climate vulnerability, pollution levels, and resource management. 175 Descriptive statistics and comparative analysis are employed to assess cross-country 176 variations and institutional performance since independence. The qualitative component 177 involves systematic document and policy analysis of environmental laws, interstate water 178 agreements, government strategies, and regional cooperation frameworks. These materials are 179 interpreted through the lens of environmental governance and environmental security to 180 evaluate regulatory capacity, enforcement mechanisms, and coordination gaps. Primary 181 sources include national legal frameworks and governmental reports, while secondary 182 sources consist of peer-reviewed academic literature, international organization assessments, 183 and policy analyses. This integrated approach enables a comprehensive evaluation of 184 structural weaknesses and governance constraints shaping environmental outcomes in post-185 Soviet Central Asia. 186

Result and Analysis 187 Central Asia's contemporary environmental governance structure cannot be understood 188 without reference to the Soviet legacy that shaped patterns of resource extraction, centralized 189 decision-making, and ecological neglect. The Soviet model prioritized large-scale agricultural 190 expansion, hydroelectric production, and industrial output, often without regard for 191 ecological sustainability. Water, in particular, was treated as a strategic production input 192 rather than a shared ecological resource. In this context, the diversion of the Amu Darya and 193 Syr Darya rivers for cotton monoculture fundamentally altered the hydrological balance of 194 the Aral Sea basin, initiating one of the gravest environmental crises of the twentieth century

195 (Oral, 2003, p. 5). 196 After independence, the dissolution of the centralized Ministry of Land Reclamation and 197 Water Resources (Minvodkhoz) in Moscow transferred water management responsibilities to 198 newly sovereign but institutionally fragile states.

Although regional mechanisms were created 199 to negotiate annual water allocations at the presidential level, micro-level reforms remained 200 limited. In many cases, Soviet-era practices such as the “use it or lose it” allocation principle 201 continued in the absence of effective sanctions or conservation incentives. This institutional 202 fragmentation directly validates the hypothesis that weak coordination and disjointed policy 203 frameworks have intensified environmental degradation and increased environmental security 204 risks. 205 The Aral Sea’s shrinkage - from 68,000 square kilometres (approximately the size of Odisha, 206 an India State) in 1960 to nearly one-tenth of its size by the mid-1990s - illustrates how 207 inherited production priorities combined with post-Soviet economic nationalism undermined 208 ecological sustainability. The resulting Aralkum desert now emits approximately 755 million 209 tonnes of toxic dust annually, spreading pollutants across the Pamir and Tien Shan mountains 210 and beyond. Soil salinity, biodiversity loss, declining agricultural productivity, and public 211 health crises demonstrate how environmental degradation intersects with socio-economic 212 instability. The environmental crisis is therefore not merely ecological but structural, linking 213 poverty, governance deficits, and regional tension. 214 Climate change has further intensified vulnerabilities. Glacial retreat in Kazakhstan and 215 neighbouring Central Asian countries reduced ice reserves by more than one-third between 216 1956 and 1990 and continues at an annual rate of 0.6-0.8 percent. Since glacial meltwater 217 contributes roughly 25 percent of annual river runoff, continued decline threatens long-term 218

water security. In a region marked by demographic growth and irrigation dependence, such 219 hydrological uncertainty increases the risk of inter-state friction. The evidence thus confirms 220 that environmental degradation, resource scarcity, and governance gaps collectively heighten 221 environmental security concerns. Regional and international

efforts, including the 222 Environment and Security Initiative (ENVSEC-2002) and subsequent coordination meetings 223 in Bishkek(OSCE, 2017, p. 16), indicate growing recognition of shared vulnerability. 224 However, while institutional architecture has expanded, implementation gaps persist across 225 national contexts. 226 Kazakhstan represents both the most institutionally developed and environmentally burdened 227 state in Central Asia. Soviet policies, including the Virgin Land Program initiated in 1953, 228 converted nearly 60 percent of pastures into cropland, much of it ecologically unsuitable. By 229 1992, although 36.5 million hectares were cultivated, only 2.3 million hectares were irrigated, 230 exposing structural inefficiencies(AllRefer, 2016). These historical interventions contributed 231 to soil erosion, desertification, and water stress. The Aral Sea catastrophe particularly affected 232 Kazakhstan's northern regions. By 2007, the water surface had declined by nearly 90 233 percent(Nugumanova, 2017, p. 4). The construction of the Kokaral Dam in 2005 partially 234 restored the North Aral Sea, reviving limited fishing activities and providing modest 235 livelihood recovery. Nonetheless, broader basin-level degradation remains 236 unresolved. Kazakhstan also inherited extensive radioactive contamination from the 237 Semipalatinsk Nuclear Testing Polygon, established in 1947. Between 1949 and 1989, 470 238 nuclear tests were conducted, releasing contamination across 19 million acres(UNDPKAZ, 239 2004, p. 54). Cancer rates in the region tripled between 1980 and 1990, with lung and 240 esophageal cancer mortality increasing significantly(Karimova, 2018, p. 1422). These figures 241 demonstrate how Soviet-era militarization generated enduring health and ecological 242 consequences. 243 Institutionally, Kazakhstan has developed an extensive legal framework. Article 31 of the 244 1995 Constitution obliges the state to protect an environment favourable to life and 245 health(UNDPKAZ, 2004, p. 20). The Law on Environmental Protection (1997), the 246 Environmental Code, 2007 (amended 62 times between 2007-2017), and the Emissions 247 Trading Scheme administered by the Department of Climate Change reflect advanced 248 legislative capacity(UNECE, 2019, p. 15), (Nugumanova L. &, 2017). Kazakhstan was also 249 among the first post-Soviet states to ratify the UNFCCC and introduce carbon

market mechanisms. Yet frequent institutional restructuring - including the abolition of the Ministry of Environmental Protection in 2014 and the transfer of responsibilities to the Ministry of Energy - illustrates governance volatility. Despite legal sophistication, enforcement deficits and bureaucratic overlap constrain effective implementation. Thus, Kazakhstan confirms the hypothesis: institutional complexity without coherent coordination perpetuates environmental risk. Kyrgyzstan's environmental governance reflects both vulnerability and adaptive experimentation. As an upstream state dependent on glacial meltwater, it faces acute climate sensitivity. The degradation of mountain glaciation threatens hydroelectric production and irrigation stability. Unlike some regional counterparts, Kyrgyzstan pursued decentralization through the Law on Pasture (2009), transferring rangeland management to community-based pasture committees (Wang, 2020, p. 2501), (Hughes, 2012, p. 11). This reform sought to correct Soviet-era overgrazing patterns and enhance local stewardship. Complementary frameworks such as the National Climate Change Adaptation Strategy (2015; updated 2020) and the Green Economy Development Strategy (2019) institutionalized climate planning. The establishment of the Climate Change Coordination Commission in 2012 improved intersectoral oversight. Civil society organizations, including the UNISON foundation, have strengthened community participation. However, fiscal constraints, limited administrative capacity, and dependence on external funding restrict policy continuity. Kyrgyzstan's experience suggests that decentralization can enhance responsiveness but requires robust coordination and sustained financial support. The persistence of glacier retreat and water-sharing tensions underscores the structural link between environmental vulnerability and regional security. Tajikistan, another upstream country, relies heavily on glacial runoff for hydropower and agriculture. National communications to the UNFCCC (2003, 2008, 2014) and the National Strategy for Climate Resilience (2019)

reflect formal commitment to adaptation(Khakimov, 277 2020, p. 7)(Scissa, 2024, p. 52). Institutionally, climate governance is shared among the 278 Executive Office of the President, the Committee for Environmental Protection, and the 279 Agency on Hydrometeorology(OSCE, 2017, p. 53). While this multi-actor approach broadens 280 participation, it also risks fragmentation. 281 Frequent floods, landslides, and glacial lake outburst events expose communities to 282 compounded environmental threats. Poverty amplifies vulnerability, and adaptation measures 283

often depend on donor-supported initiatives. Tajikistan therefore exemplifies how limited 284 institutional capacity constrains the operationalization of environmental strategies, 285 reinforcing the central hypothesis. 286 Uzbekistan, as a downstream state heavily dependent on irrigation for cotton, bears 287 substantial responsibility for Aral Sea depletion. Water diversion policies during the Soviet 288 period entrenched monoculture dependence. The resulting desertification and salinization 289 have severely degraded agricultural productivity. Recent reforms signal a shift. Ratification of 290 the Paris Agreement (2018), the Environmental Protection Concept (2019), and the Green 291 Economy Development Strategy (2019) outline sustainability commitments. Presidential 292 Decree No. PP-436 of December, 2022, operationalizes measurable green growth 293 targets(World Bank Group, 2023, p. 18). Initiatives such as Yashil Makon and large-scale 294 renewable energy investments demonstrate policy ambition (Bychkova, 2023, p. 295 112),(Nematov, 2025). 296 However, implementation remains challenged by irrigation inefficiency, institutional 297 centralization, and rural vulnerability. Media narratives and international finance mobilization 298 have increased public engagement, yet structural water dependence persists. Uzbekistan's 299 trajectory illustrates incremental institutional reform within an inherited resource-intensive 300 model. 301 Turkmenistan's governance model remains highly centralized. The National Climate Change 302 Strategy and afforestation drive under the National Forestry Programme (since 2013) reflect 303 symbolic commitment. Its participation in Rio+20 and international forums indicate 304

diplomatic engagement(OSCE, 2017, p. 57).Nevertheless, expanded gas production has  
305 elevated emissions, and irrigation inefficiencies continue to strain water resources.  
Limited 306 transparency and civil society engagement restrict policy accountability. While  
political 307 stability is relatively high, environmental governance remains state-centric,  
reinforcing 308 regional fragmentation. 309 Policy Recommendations 310 1. Establish a  
binding, rules-based transboundary water framework with enforceable 311 compliance  
mechanisms. 312 2. Clarify mandates among ministries and integrate water, energy, and  
agriculture 313 policies. 314

3. Scale up community-based resource management models, especially in irrigation and  
315 pasture systems. 316 4. Prioritize glacier monitoring, water-saving irrigation  
technologies, and drought317 resilient crops. 318 5. Institutionalize access to  
environmental information and strengthen civil society 319 oversight. 320 6. Integrate  
environmental risk assessments into regional security cooperation 321 frameworks. 322  
Conclusion 323 The findings confirm that Soviet environmental legacies structured  
centralized extraction324 oriented governance. Post-independence fragmentation,  
inconsistent decentralization, and 325 weak enforcement mechanisms have hindered  
effective implementation. While legal and 326 institutional reforms are evident across the  
region, coordination deficits 327 persist.Environmental degradation - manifested in water  
scarcity, glacial retreat, 328 desertification, and radioactive contamination - intersects  
directly with socio-economic 329 vulnerability and regional security. The hypothesis that  
weak institutional coordination and 330 fragmented policy frameworks exacerbate  
environmental degradation and heighten security 331 risk is therefore substantiated. 332  
Central Asia's environmental governance trajectory reveals a complex interplay between  
333 inherited structural legacies and contemporary institutional fragmentation. Addressing  
these 334 systemic weaknesses is essential not only for ecological sustainability but also  
for regional 335 peace and human security. 336 337 338 339 340 341 342 343

344 345 346 347 348 349 350 351 References (\*indicate primary sources) 352  
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