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The River Contract As An Infrastructure Of Care For Nature-Based Solutions: From Negotiated Planning To Adaptive Basin Management

Oliviero Casale, Paola Rinaldi
Uniprofessioni, Italy; Bologna University, Italy.

Abstract
The River Contract can be interpreted as one of the most promising instruments for making Nature-based Solutions operational in riverine territories, provided that its nature is not confused with that of the material interventions it may promote. A wetland, a riparian buffer, a phytoremediation system, a rain garden, a drainage trench or a natural flood storage area can be considered Nature-based Solutions in a physical, ecological and design sense; the River Contract operates on a different plane, because it builds the institutional, organisational and social conditions through which such solutions can be selected, designed, financed, implemented, cared for, monitored and adapted over time.
Read in this way, the River Contract takes on the profile of an infrastructure of governance, implementation and care. Its function is not exhausted by participation, nor by the production of an Action Programme, but concerns the capacity to organise a stable system of relations among public and private actors, operational responsibilities, economic resources, administrative instruments, procurement procedures, data, monitoring, learning and management continuity across the basin. Its value emerges especially when Nature-based Solutions are not considered isolated interventions, but components of a broader territorial strategy aimed at ecological regeneration, risk reduction, climate adaptation and quality of life for local communities.
The European and international technical and methodological framework confirms the relevance of this reading. The European standard EN 18140, adopted as UNI EN 18140:2026, contributes to defining terminology and classification for Nature-based Solutions; the ISO/UNI ISO 3710X series and, more broadly, the ISO 371XX corpus introduce references on management systems, descriptive frameworks, smart infrastructures, indicators and methodological approaches for sustainable cities and communities; the CEN Workshop Agreement on nature-based insurance and investment solutions highlights the need to demonstrate measurable risk reduction and financial sustainability across the life cycle; the IUCN Global Standard for Nature-based Solutions provides criteria for assessing ecological quality, inclusive governance, adaptive management and institutional integration; the 2025 OECD paper on integrating NbS into River Basin Management Plans directly links nature-based solutions to basin planning; the UNaLab handbook emphasises the life cycle of NbS, from co-creation to co-monitoring; the 2024 WRI framework provides tools for selecting solutions in relation to water, heat and ecological risks; and the 2022 EIP-AGRI report introduces the role of NbS in agricultural water management and small rural basins [1], [2], [5], [6], [7], [8], [9], [10], [11].
In Italy, Legislative Decree No. 152 of 3 April 2006, and in particular Article 68-bis, recognised River Contracts as voluntary instruments of strategic and negotiated planning that contribute to the definition and implementation of district planning instruments at basin and sub-basin scale. In Italy, Ministerial Decree No. 190/2025 updated the National Observatory of River Contracts at the Ministry of the Environment and Energy Security, strengthening national coordination, the harmonisation of processes and the use of the National River Contracts Platform as an operational tool for data collection, archiving and processing [12].
The thesis advanced in this article is that the River Contract should not be understood as an ancillary participatory procedure, nor as an administrative container for environmental interventions, but as an operational platform through which Nature-based Solutions can become part of a stable policy of basin care. This reading makes it possible to move beyond the logic of the punctual project, often fragile and fragmented, and instead to build a coordinated system of actions, responsibilities, monitoring and learning capable of acting simultaneously on water, soil, biodiversity, landscape, local economies and communities.

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I. From The Watercourse As Hydraulic Work To The Basin As Living System

The River Contract arises from the need to abandon a purely sectoral reading of the watercourse. For a long time, the river has been treated above all as a technical object to be regulated, embanked, straightened, dredged or secured through defence works. This approach has produced important results in certain historical phases, but it has also contributed to separating the river from its territory, reducing it to a drainage channel, a

disposal infrastructure or an administrative margin. The climate crisis, the increase in extreme events, biodiversity loss, soil sealing, artificialisation of the hydrographic network and habitat fragmentation now reveal the limits of that view and make a paradigm shift necessary.

The river should be interpreted as a living and relational system in which water, soil, sediments, vegetation, fauna, agricultural activities, landscapes, local economies, settlements, collective memories and social uses interact continuously. An intervention on the channel never concerns only the channel, just as a change in agricultural land use, a new urban development, a water abstraction or the loss of a riparian strip can produce effects that manifest elsewhere, at different times and with different intensities. This complexity requires work at basin or sub-basin scale, overcoming administrative fragmentation and the separation between water, urban, agricultural, landscape and environmental policies.

The definition of Nature-based Solutions taken up by the European standard EN 18140 is useful precisely because it places intervention within a relationship between ecosystems and societal challenges. NbS are actions aimed at protecting, conserving, restoring, sustainably using and managing natural or modified ecosystems, with the objective of addressing social, economic and environmental challenges while generating benefits for human well-being, ecosystem services, resilience and biodiversity. The same approach recalls principles such as biodiversity, ecosystem integrity, long-term sustainability, adaptive management, inclusive governance, social equity and multifunctionality [1].

Transferred to the River Contract, this definition allows a further conceptual step: the river basin is not merely the physical space in which works or interventions are located, but becomes the ecological, social and territorial system to be cared for. Nature-based Solutions provide the technical and design repertoire for regenerating compromised functions, while the River Contract can provide the institutional, managerial and participatory architecture required to ensure that such solutions do not remain isolated episodes, but become part of a continuous governance pathway.

The volume Costruire Contratti di Fiume gives theoretical depth to this approach, describing the River Contract as an instrument of negotiated territorial planning aimed at caring for places collectively and participatively, starting from their water component. In this reading, care is not a secondary activity that follows design, but a political and social task requiring attention, responsibility, competence and responsiveness [13].

II. The River Contract As An Institutional Infrastructure For Nature-Based Solutions

The relationship between the River Contract and Nature-based Solutions becomes clearer when the material dimension of the solution is distinguished from the organisational dimension that makes its implementation possible. A wetland, a buffer strip, riparian reforestation, a floodable park or a phytoremediation system act directly on ecological and hydrological processes; the River Contract, by contrast, works on the conditions that allow such interventions to be chosen, implemented, financed, maintained, monitored and adapted. Its function is therefore less visible physically, but essential managerially.

The category of institutional infrastructure helps to explain this function. An infrastructure is not only a road, a water network or an embankment; it can also be a stable system of rules, relations, procedures, responsibilities and data. The River Contract operates precisely in this direction, because it connects public and private actors, integrates plans and programmes, builds a framework of shared objectives, defines actions, assigns responsibilities, intercepts resources, supports participatory processes and accompanies implementation over time. Without such an infrastructure, many NbS risk remaining experimental interventions, poorly connected to planning and difficult to maintain.

In Italy, Ministerial Decree No. 190/2025 gives this interpretation institutional reinforcement. The decree refers to Article 68-bis of Legislative Decree No. 152/2006, according to which River Contracts contribute to the definition and implementation of district planning instruments at river basin and sub-basin level, pursuing water protection, proper management of water resources, enhancement of river territories, safeguarding against hydraulic risk and local development [12].

The same decree updates the National Observatory of River Contracts at the Ministry of the Environment and Energy Security, assigning it guidance and coordination functions to harmonise the application of River, Lake, Lagoon, Aquifer, Estuary and Coast Contracts across the national territory. The Observatory operates through the National River Contracts Platform, conceived as an online operational tool for collecting, archiving and processing data [12].

The consequence is significant: the River Contract can no longer be treated only as a local participatory practice, but should be placed within a broader water governance architecture, connected to basin planning, monitoring, risk prevention, climate adaptation and administrative capacity-building.

III. Participation, Responsibility And Quality Of The Process

Recent literature on River Contracts shows that the quality of the process matters at least as much as the content of the Action Programme. A River Contract can be interpreted either as a territorial project to be

implemented or as a collective process for building responsibility. The difference is not marginal. In the first case, the river risks being treated as an object to be transformed through decisions taken by a few actors; in the second, it becomes a common good around which relationships, shared knowledge, trust and a sense of belonging are built.

Venturini and Visentin, analysing three River Contracts in Friuli Venezia Giulia, show that the ratification of a Contract does not by itself demonstrate the effectiveness of the pathway. The quality of the River Contract depends on the degree and type of participation, the way actors are involved and the possibility for local communities to effectively influence decisions. The authors observe that participatory events and the simple circulation of information are not enough to produce active involvement; for the Contract to strengthen a fluvial sense of place, citizens must be enabled to move from passive recipients of plans to genuine territorial actors [14].

This consideration is also essential for Nature-based Solutions. A nature-based solution does not function only because it is technically well built, but because it enters a network of meanings, uses, responsibilities and care practices. A wetland created without involvement may be perceived as a constraint, while the same wetland, if designed and followed through a participatory process, can become ecological infrastructure, educational space, civic presence and identity-forming place. The River Contract represents the space where the technical performance of the NbS meets social legitimacy and management continuity.

The Roiello di Pradamano case effectively shows how care can emerge from social practices even before administrative instruments. In that context, a citizens' committee promoted meetings, events, bank-cleaning activities, school activities, walks, mapping and cultural initiatives, helping to reveal the environmental, historical, landscape, emotional and memorial value of the canal. Through these practices, the watercourse ceased to be perceived as a merely hydraulic element and became once again part of collective life [13], [14].

When it operates in this way, the River Contract produces not only works or interventions, but widespread competences, relations of trust, shared responsibility and capacity to act on the territory.

IV. Standards, Technical References And Quality Criteria

The River Contract can be made more robust when it is related to the technical framework that is consolidating at European and international level around Nature-based Solutions, sustainable cities and adaptive management. The ISO/UNI ISO 3710X series and, more broadly, the ISO 371XX corpus offer references on management systems, descriptive frameworks, indicators, smart infrastructures and methodological tools for sustainable cities and communities. In particular, ISO/UNI ISO 37101 concerns the management system for sustainable development in cities and communities; ISO/UNI ISO 37105 offers a descriptive framework for cities and communities, useful for understanding and structuring an information base for more informed decisions; ISO 37155-1:2020 concerns the framework for the integration and operation of smart community infrastructures across the life cycle, considering opportunities and challenges arising from interactions among infrastructures, stakeholders and operational phases [2], [5].

It is important to clarify that ISO 37155-1:2020 is not a specific standard on urban green infrastructure. Its object is smart community infrastructures and their interactions across the life cycle, although this approach can be useful for reasoning about coordination among infrastructures, responsibilities and adaptive management. Similarly, UNI 11973:2025 should not be referred to generically as a standard on sustainable urban planning, because its specific object is the contribution of buildings to sustainability and the methodological model for integrating and interconnecting sustainable buildings in cities, with implications for territorial governance, urban planning and sustainable public policies [4].

At the Italian level, UNI 11965:2024 instead concerns requirements for active involvement of the community and interested parties in local government management, and for this reason it can be cited more appropriately when discussing participation, stakeholder engagement and local governance. The UNI materials also refer to a standard under development on the planning, design, implementation, management and care of green infrastructures for the sustainable development of cities; because this is an ongoing standardisation activity, it must be distinguished from already published standards [3].

At the European level, the CEN Workshop Agreement on nature-based insurance and investment solutions introduces a complementary perspective, because it connects NbS to measurable risk reduction, financial sustainability over the life cycle, net positive outcomes for nature, accountability, data transparency and credible monitoring [6]. The IUCN Global Standard for Nature-based Solutions, also referred to by the OECD, UNaLab and the IUCN presentation on freshwater ecosystems, proposes criteria concerning the capacity to address societal challenges, scale-informed design, net gain for biodiversity and ecosystem integrity, economic sustainability, inclusive governance, management of trade-offs, evidence-based adaptive management and integration into the appropriate institutional context [7], [8], [9].

The River Contract can use these references not to become locked into a standardised procedure, but to strengthen its quality. Standards and technical references help prevent participation from remaining generic, sustainability from being declared but not measured, care from being left to goodwill, and NbS from being selected without a coherent assessment of benefits, risks, costs, responsibilities and expected performance.

V. From River Basin Planning To Implementation Capacity

The contribution by Casale and Rinaldi makes it possible to further clarify the relationship between Nature-based Solutions, river basin planning and River Contracts. The authors propose an integrated technical framework in which NbS are not considered simple green measures, but verifiable, technically demanding solutions comparable, both technically and institutionally, with grey or hybrid alternatives. In this reading, the full operability of NbS depends on the interaction between a rigorous conceptual definition, a planning scale consistent with hydrological functioning, inclusive forms of social construction of measures, appraisal methods capable of representing overall public value and institutional arrangements able to translate strategies and programmes into implementable and investable projects [25].

The decisive issue concerns scale. The river basin is assumed as the privileged territorial unit for organising action, because water quality, hydromorphological configurations, sediment transport, flood risk, land uses and upstream-downstream relations do not respond to administrative boundaries, but to systemic logics. Within this framework, negotiated instruments such as the River Contract can be read as operational devices situated within a broader architecture of river basin governance, useful for territorialising strategic objectives, coordinating actors, building shared priorities and making portfolios of spatially distributed interventions implementable [25].

The same literature nonetheless signals a structural problem: NbS often remain confined to demonstration initiatives or localised interventions, entering only episodically into ordinary processes of territorial planning, public appraisal and investment programming. Casale and Rinaldi refer to the implementation gap of NbS, clarifying that many projects do not become genuine investment projects because they lack a sufficiently solid business case, an adequate governance arrangement, a coherent procurement strategy and a credible financial structure [25]. The River Contract can be located precisely at this critical point, transforming ecological intervention into an implementable, financeable and monitorable programme.

VI. From Basin Planning To Local Action

The 2025 OECD paper on integrating NbS into river basin management allows the River Contract to be situated within a broader relationship between district planning and local action. In the water sector, the OECD presents Nature-based Solutions as the planned and deliberate use of ecosystem services to improve water quantity and quality and increase resilience to climate change, often in combination with conventional infrastructures [8].

The document also recalls the role of the Water Framework Directive as a driver for integrating NbS into River Basin Management Plans, because basin management plans must contain measures to achieve good water status. This provides a very useful reading for River Contracts: Nature-based Solutions should not be seen as decorative or compensatory additions, but as effective measures of basin management [8].

The River Contract can be located precisely between the strategic level of district planning and the operational level of territories. It does not replace the Basin Management Plan, but can make its implementation more concrete through the involvement of local actors, the building of consensus, the identification of priorities, the coordination of financing, the definition of responsible subjects and the monitoring of effects.

In Italy, the progress report of the Ministry of the Environment and Energy Security on the commitment concerning River Contracts confirms this role, highlighting that River Contracts are implemented as measures of River Basin District Management Plans and of the Italian Programme of Measures under the Marine Strategy. In Italy, Ministerial Decree No. 190/2025 further consolidates this direction through coordination among River Basin District Authorities, the National Observatory and the National Platform [12], [24].

VII. From The “Sponge City” Model To The “Sponge Basin”

The case of the Metropolitan City of Milan shows how Nature-based Solutions can be organised as a territorial strategy. The “Città Metropolitana Spugna” strategy arises from issues typical of urbanised territories, such as runoff, heat islands, intense rainfall events, impermeabilisation and loss of natural absorption capacity. The Integrated Urban Plan envisages 88 interventions in 32 municipalities, with 50 million euros of PNRR funding, aimed at eco-sustainable urban regeneration and at reducing the effects of climate change [15].

The solutions indicated for water management, such as rain gardens, detention basins, permeable pavements, drainage trenches and vegetated filtration systems, fully belong to the repertoire of urban NbS. If transferred to the fluvial scale, the sponge city logic can become a sponge basin strategy, in which the objective

is not only to move water quickly downstream, but to retain it, slow it down, infiltrate it, purify it and return it to ecological processes.

A sponge basin is not built only along the main channel, but also in agricultural soils, riparian strips, wetlands, minor drainage networks, urban spaces, car parks, disused industrial areas, parks and restored quarries. For this vision not to remain a sum of fragmented interventions, an instrument capable of coordinating it is needed. The River Contract can perform this function, because it connects material actions to a framework of responsibility, monitoring and care.

The City Blues report reinforces this approach, showing that urban water management at catchment scale requires consideration of the hierarchy among sub-catchments, urban catchments and natural watersheds, because urban expansion alters natural drainage patterns and requires land use, drainage systems, infrastructure and natural functions to be reconsidered together [26].

VIII. From The Action Plan To The NbS Programme Of Measures

The OECD contribution introduces a useful element for strengthening the operational dimension of River Contracts: NbS must be integrated into Programmes of Measures. In the Alazani-Iori case, the document proposes revising the Programme of Measures by explicitly including nature-based solutions linked to the pressures to be mitigated. Nature-based measures are considered complementary to traditional infrastructures, as in the case of wetlands for wastewater treatment, riparian strips for reducing sediments and nutrients, or the renaturalisation of banks and channels for water retention and flood risk mitigation [8].

This approach can be transferred to the River Contract, whose Action Plan could evolve into a genuine NbS Programme of Measures. Such a Programme should not merely list projects, but should organise actions according to environmental and territorial pressures, ecosystem functions to be regenerated, expected benefits, implementation responsibilities and monitoring indicators.

In Italy, the case of the Rio Capodacqua-Santa Croce in central Italy confirms the usefulness of this operational structure. The preprint dedicated to this experience describes the River Contract as an inclusive and voluntary instrument of strategic and negotiated planning, aimed at protecting and improving the management of water resources, enhancing the river ecosystem and mitigating hydraulic risk. The proposed actions concern pollution, anthropogenic threats, conservation of riparian habitats, species of conservation interest and flood risk mitigation works [16].

The text should be used with caution, because it is a preprint not subjected to peer review, but it is nevertheless interesting as an applied case: it shows a coherent sequence among knowledge analysis, strategic plan, action programme, responsible subjects, funding sources and verification of consistency with European directives on habitats, water and flood risk [16].

IX. Cataloguing Solutions In Order To Choose Better

A River Contract oriented towards NbS should have an operational catalogue, not to transform the complexity of the basin into a rigid list of interventions, but to help actors select the solutions most appropriate to existing pressures, territorial characteristics, scale of action and available management capacities. The OECD tables indicate, for rivers and lakes, actions such as river re-meandering, floodplain restoration, riparian buffer strips and wetland creation and restoration, associating them with benefits for water quality, flood risk reduction, biodiversity, recreation and landscape [8].

The 2024 WRI framework proposes an even broader catalogue, including natural lands and forests, tree plantings, sustainable agriculture, open spaces and parks, greenways, riparian floodplain, creek daylighting, rain gardens, rainwater harvesting, green roofs and walls, wetlands, coastal habitats, beaches and dunes. The document also distinguishes four operational modes which, translated into the logic of the River Contract, can be read as protection, enhancement, restoration and construction of new ecological functions [10].

At basin scale, a catalogue of this kind could be used to build a matrix capable of linking pressure, solution, scale, responsible actor, expected benefits, indicators, resources and care plan. In this way the River Contract would not remain a container of intentions, but would become an instrument of selection, prioritisation and implementation.

X. Strategies For Water, Heat And Biodiversity

The WRI framework proposes an effective classification of NbS according to the functions they can perform. For water management, it identifies five strategies: infiltrating water into the soil, temporarily retaining it and releasing it slowly, conveying it safely, capturing it for reuse and improving its quality [10].

Applied to the River Contract, these strategies become an operational grammar for building coherent actions. Infiltrating water means working on permeable soils, rain gardens, vegetated strips and regenerative agricultural practices. Slowing runoff means reconnecting floodplains, creating naturalised basins, floodable parks and wetlands. Conveying water safely implies the renaturalisation of minor drainage networks,

daylighting culverted watercourses, using green-blue corridors and sustainable urban drainage systems. Reusing water requires collection systems, irrigation reuse and controlled recharge. Purifying water means using biofilters, phytoremediation, vegetated ditches and constructed wetlands.

For biodiversity, the same framework proposes strategies aimed at protecting existing habitats, increasing vegetation diversity, widening ecological buffer areas and connecting fragmented natural spaces. The strength of this approach lies in the possibility of linking hydraulic safety, ecological continuity, landscape quality and community well-being, avoiding the treatment of each function by a separate sector [10].

XI. Agriculture, Water, Forests And Small Basins

The 2022 EIP-AGRI report is particularly relevant because it brings Nature-based Solutions into the relationship between agriculture, water and climate change. The Focus Group defines NbS for agricultural water management as solutions inspired and supported by nature that improve water availability, quality and use efficiency, as well as the protection of farms against floods or excess water. These solutions must generate environmental, social and economic benefits, contribute to good water governance, introduce more diverse natural processes into farms and landscapes, and support biodiversity and ecosystem services [11].

The report groups agricultural NbS into three broad categories: practices that increase water storage in the soil root zone, interventions to protect watercourses and margins such as vegetated buffers and barriers, and green infrastructures for retaining, regulating and storing water on the farm or in the small agricultural basin [11].

For River Contracts this point is decisive, because many basins consist of agricultural mosaics in which water quality, flood risk, groundwater recharge and biodiversity depend largely on soil management practices. The care of the river is not played out only in the channel, but also in fields, ditches, drainage systems, hedgerows, margins and small reservoirs. For this reason, farmers should be recognised as central actors in the NbS strategy and not as collateral actors.

At basin scale, it is also necessary to include forested areas, slopes and headwater zones, which influence erosion, sediments, hydrological regulation, fires, pests and biodiversity. The ETC-CA report on NbS for forest disturbances under climate change shows how nature-based interventions in forest contexts should be read together with biophysical, socio-economic and governance factors, confirming that basin resilience cannot be separated from the management of forest and mountain systems [28].

XII. The Life Cycle Of NbS

The UNaLab Implementation Handbook introduces an essential methodological element, namely the need to manage NbS along a life cycle that includes identification of the framework, definition of pressures and challenges, selection of solutions and indicators, establishment of the monitoring plan, implementation, evaluation of results and feeding of a knowledge base [9].

Applied to the River Contract, this scheme suggests constructing the Action Plan as a progressive process in which basin pressures are identified together with actors, objectives are co-defined, NbS are selected according to criteria of ecological and managerial coherence, indicators are identified before implementation, monitoring accompanies interventions and care becomes an integral part of the decision-making cycle.

UNaLab also emphasises co-creation, that is, the structured involvement of public administrations, research, enterprises and citizens. NbS are in fact socio-ecological-technological innovations characterised by uncertainty, and for this reason require participatory environments in which experimentation and learning are part of the process [9].

The City Blues report adds a strongly operational dimension to this approach, because it describes NbS as solutions that mimic natural processes in semi-controlled environments and modify their performance in relation to seasonality, maintenance, drought, extreme events and management modes. The document stresses the need to consider engagement, operation and monitoring across the entire life cycle, with feedback and feedforward loops capable of adapting the functioning of solutions over time [26].

The River Contract can adopt this logic as a method, transforming episodic participation into continuous co-production of diagnosis, solutions, monitoring and care.

XIII. Public Procurement And Administrative Capacity

A point often underestimated in River Contracts concerns the transition from the design idea to the administrative procedure. NbS must be not only imagined and shared, but also procured, designed, tendered, executed and managed. The European Commission report on public procurement of NbS clarifies that public procurement for Nature-based Solutions does not coincide with simple green public procurement, because NbS are products or services to be acquired, whereas GPP and SPP are procurement practices that incorporate environmental and social criteria [17].

The document identifies barriers directly related to administrative capacity: limited knowledge of NbS among public procurement officers, lack of shared typologies, difficulty in finding qualified suppliers, problems of community involvement, institutional and legal barriers, perceived reputational risk, limited access to finance and conflicts over maintenance responsibilities when budgets and roles are not defined in advance [17].

For a River Contract, the implication is clear. Including a riparian strip, a wetland or a rain garden in the Action Plan is not enough if the contracting authority, the procedure, technical requirements, performance criteria, care plan, indicators, multi-year budget and allocation of responsibilities are not clarified. NbS therefore require not only ecological vision, but also managerial, administrative and contractual capacity.

The analysis by Casale and Rinaldi confirms this view, because it links NbS implementation not only to technical correctness, but to the presence of a solid business case, adequate governance, a coherent procurement strategy and a credible financial structure [25]. The River Contract can help integrate these elements into a single territorial process.

XIV. From Maintenance To Care

One of the most recurring limits of Nature-based Solutions concerns the difficulty of ensuring their functioning over time. Speaking only of maintenance risks being reductive, because the term refers to a work to be kept efficient, whereas NbS are living systems that evolve, adapt, mature, may degrade and require continuous observation. The concept of care makes it possible to grasp this dynamic nature more effectively.

The case of the Metropolitan City of Milan expresses this point directly: NbS are not static like concrete, but living systems, and their effectiveness in draining water and cooling the city depends on continuous care. When neglected, they lose hydraulic and ecological function [15].

The Turin case confirms the critical nature of the issue. The materials on urban regeneration through NbS highlight that no plan addresses maintenance and collaborative governance holistically, as they are often treated as secondary elements of the planning process [23].

The volume Costruire Contratti di Fiume offers a further theoretical foundation, because it interprets care as the general objective of the River Contract and connects it to the political and social dimension of inhabiting a territory. Caring for a basin means paying attention to ecological processes, assuming responsibility, developing competences and responding to change [13].

A River Contract oriented towards NbS should therefore build a pact of care for the basin, in which not only the interventions to be implemented are defined, but also the subjects who observe, intervene, finance, monitor, communicate, update priorities and are responsible for functioning over time. Care includes an ecological dimension, linked to habitats, biodiversity and fluvial continuity; a hydraulic dimension, linked to the capacity of the system to slow, store, infiltrate and purify; a landscape dimension, linked to the quality of places; a social dimension, linked to recreation, education and involvement; and an institutional dimension, linked to responsibilities, resources, data and administrative continuity. Care includes maintenance, but goes beyond it, because it is not limited to preserving performance; it accompanies the evolution of the river system so that it continues to produce safety, biodiversity, environmental quality, well-being and resilience.

XV. Monitoring, Evaluation And Adaptive Learning

Monitoring is the condition that makes it possible to distinguish a declared NbS from a verifiable NbS. The technical document of the National Observatory of River Contracts states that monitoring is an essential component of any decision-making process, because it serves to verify whether the process works, whether objectives are being achieved and whether actions and strategies need to be redirected in time. This need is even more relevant in River Contracts, where actors participate voluntarily and may abandon the process if they do not see visible results [18].

The same document clarifies that monitoring must accompany all phases of the Contract, from initiation to implementation of the Action Programme. It does not propose a single methodology valid for every context, but a toolbox that allows actors to orient themselves among different forms of monitoring, from the Declaration of Intent to the implementation phase [18].

The document explicitly links River Contracts and Nature-based Solutions. Soil consumption, urbanisation, deforestation, resource waste and river artificialisation alter the hydrological response of basins and the ecological processes of rivers and floodplains; the River Contract therefore becomes a transdisciplinary opportunity to recover the ecosystem functionality of green water through NbS, controlling their effectiveness by monitoring ecological functions and ecosystem services [18].

Monitoring may concern both what is implemented and the effects produced, as well as the process itself, namely the way governance is organised and produces consequences on the territorial context. For this reason, monitoring can be considered the technical form of care: it allows the River Contract not to stop at signature or at the Action Programme, but to verify over time whether NbS produce hydrological, ecological, social and economic benefits, adapting decisions on the basis of evidence.

XVI. National Platform And Traceability Of Processes

The National River Contracts Platform represents an important step towards transforming River Contracts into monitorable and comparable processes. The monitoring document describes it as a web application created by the National Observatory of River Contracts, with the purpose of making available to the national community an information portal and a working environment dedicated to the integrated and participatory management of hydrographic systems. The platform serves to share technical content, collect data on River Contract experiences, support individual processes in monitoring and produce synoptic frameworks and statistical analyses at regional, district and national scale [18].

The platform consists of a database and a publication and service-access portal. Information can be displayed through integrated GIS or through tabular and graphical reporting that can be exported. In Italy, Ministerial Decree No. 190/2025 confirms this function, as the Observatory carries out monitoring activities of River Contracts using the National Platform as an online operational tool for data collection, archiving and processing [12].

The shift from narrative to traceability is relevant. A River Contract that has data, indicators, maps and reports can make its progress visible, strengthen actors' trust, compare itself with other processes and correct actions. Basin care is thus supported by an information infrastructure that increases transparency and learning capacity.

XVII. Finance, Ecosystem Value And Economic Sustainability

Economic sustainability is one of the most difficult conditions for the diffusion of Nature-based Solutions. The OECD notes that their implementation is hindered by financial, technical, regulatory and governance barriers, including land availability, insufficient or fragmented funding, uneven governance, lack of technical expertise, limited familiarity with NbS business models, regulations that favour grey infrastructure and resistance to change [8].

The UNEP Finance Initiative paper highlights the potential role of investors and financial institutions. Private finance for NbS remains limited compared with overall needs, but banks, investors and insurers can help direct financial flows towards nature-positive outcomes, climate mitigation, adaptation and biodiversity [19].

The UNEP report on the economics of NbS also introduces a note of caution. Benefits depend on geographical context, scale, ecosystem maturity and trade-offs among objectives. An NbS may produce multiple ecosystem services, but not every solution is automatically optimal in every place or at every moment; clear definitions, explicit objectives, assessments at appropriate spatial and temporal scales and adaptive management plans are needed [20].

Casale and Rinaldi further insist that traditional appraisal methods, if applied in isolation, risk underrepresenting ecosystem co-benefits, distributive effects, systemic resilience, avoided damages and the cost of inaction. For this reason, integrating NbS into basin planning requires a broader appraisal framework capable of representing their overall public value, not only immediate economic convenience [25].

For the River Contract, this implies the need to develop stable financial instruments: basin care funds, payments for ecosystem services, environmental compensations, public-private partnerships, ESG finance, green bonds, insurance instruments linked to risk reduction, results-based financing and agreements with local enterprises. NbS should not be financed only as initial works, but as performance systems over time.

XVIII. Mainstreaming NbS And System Capacity

One of the recurring problems of Nature-based Solutions is the difficulty of moving from experimentation to normalisation within ordinary regimes of infrastructure, planning and investment. The NATURVATION report describes this transition through the concept of mainstreaming, arguing that NbS must become part of urban and territorial infrastructure regimes, meaning the stable configurations of institutions, techniques, resources, procedures and practices that determine what is considered normal in urban and territorial development [27].

The "stepping stones" identified by NATURVATION are particularly useful for reinterpreting the River Contract as a management infrastructure. An effective River Contract should help provide a public mandate for NbS, include them in contractual requirements, create intermediary forms capable of overcoming institutional silos, generate partnerships among the public sector, the private sector and the third sector, build co-financing mechanisms, work with investment cycles, improve data and monitoring, develop appraisal models and strengthen professional skills [27].

In this reading, the River Contract does not merely promote individual actions, but can become an instrument for making Nature-based Solutions an ordinary part of basin governance. Its capacity to coordinate policies, resources, actors and responsibilities makes it particularly suitable for supporting the shift from pilot experiences to structural programmes.

XIX. Landscape And Transformational Adaptation

The River Contract can also be interpreted as a strategic and integrated landscape project. The contribution on the Val di Pesa River Contract recalls that watercourses historically structured the morphology of territories, settlement systems, agroforestry uses, the agrarian pattern and the collective imagination. With modernisation, many river landscapes were diverted, culverted, drained and weakened from an ecological, cultural, hydrogeological and hydraulic point of view [21].

According to this reading, River Contracts have contributed to changing the point of view on watercourses, trying to reaffirm the river as a force line of a territorial project oriented towards sustainability and resilience. The River Contract is thus interpreted as a plan-process, not as an additional sectoral plan, capable of developing integrated projects among hydraulic defence, hydrogeological balance, protection of landscape and environmental values, and sustainable local economies [21].

The relationship with Nature-based Solutions becomes particularly strong. A riparian strip, a wetland or a floodable park are not only technical solutions; they also produce landscape, accessibility, identity, memory and well-being. For this reason, the River Contract can be interpreted as a space of convergence among ecology, territorial project and care for places.

The contribution on the Val di Pesa also proposes reading River Contracts as instruments useful for transformational adaptation, that is, an adaptation that is not limited to incremental, punctual or corrective responses, but aims at deeper changes in settlement, economic and governance models. Many climate adaptation policies remain anchored to an emergency approach, in which action is taken after a flood or after damage. The River Contract can instead shift attention towards active prevention, ecological regeneration and the transformation of the relationship between community and basin [21].

The international case of the Bengawan Solo basin in Indonesia confirms the relevance of this approach. The study shows that NbS in riverine systems can include green dams, woodland creation, wetlands and storage ponds, integrated into river management and territorial planning among administrative levels. At the same time, it points out that water policies are often only partially connected to the concept of NbS and that poor coordination among actors involved can limit their effectiveness [22].

The volume Incorporating Nature-based Solutions in Community Climate Adaptation Planning also reinforces the connection between NbS and community climate adaptation, showing how nature-based solutions can reduce climate risks and improve quality of life, including in combination with conventional infrastructure in green-gray configurations [29].

XX. Multilevel Governance, Cooperation And Partnerships

Governance is a substantial condition for Nature-based Solutions, because most effective solutions require the involvement of multiple administrative levels, several policy sectors and different categories of actors. The proGIreg project in Turin, particularly in Mirafiori Sud, shows a quadruple-helix logic based on interaction among public administration, academic research, civil society and private enterprises. The materials indicate 7 NbS implemented in Turin and a network of actors including the City of Turin, universities, CNR, ARPA Piemonte, foundations, cooperatives and enterprises [23].

The IUCN presentation on freshwater ecosystems further broadens the perspective, emphasising that in transboundary basins NbS can become an entry point for dialogue, cooperation and agreements, because they mobilise a broader set of interests and resources, including NGOs, the private sector, local communities, indigenous peoples and academia. NbS may be negotiated and implemented through binding and non-binding instruments, contributing to institutional coordination across governance levels and sectors [7].

The United Nations World Water Development Report 2023 reinforces this cooperative dimension, stating that achieving Sustainable Development Goal 6 requires partnerships and cooperation across all dimensions of sustainable development. The report emphasises that almost all water-related interventions involve some form of cooperation and that water security, food security, energy security, climate impact reduction and ecosystem protection must be addressed through coordinated work among actors, sectors and decision-making levels [30].

Even when the basin is not transboundary in an international sense, the logic remains valid, because every basin is almost always inter-municipal, intersectoral and multilevel. The participation of municipalities, basin authorities, regions, water service managers, reclamation consortia, farmers, parks, enterprises, schools, associations, citizens, technical experts and research requires an organisation capable of transforming involvement into operational responsibility. The River Contract must therefore clarify who designs, who authorises, who finances, who implements, who cares, who monitors, who communicates, who updates and who evaluates. Without such a matrix of responsibility, NbS risk remaining isolated or demonstrative interventions.

XXI. Towards A Nature-Positive Device

In light of the standards, technical references and cases analysed, the River Contract can be read as a nature-positive device if it can support certain fundamental transitions. The first concerns the transition from project to life cycle, because every NbS must be planned, designed, implemented, cared for, monitored, financed and adapted. The second concerns the transition from participation to responsibility, since the River Contract must generate verifiable commitments and not merely consensus. The third concerns the transition from sectoral mitigation to ecosystem multifunctionality, given that a fluvial NbS should not be evaluated only for hydraulic risk reduction, but also for water quality, biodiversity, climate, health, landscape, education, inclusion and economic value.

These transitions are accompanied by a further transformation, which consists in moving from the work to the ecosystem service. A riparian strip, a wetland or a floodable park are not only physical interventions, but devices that produce water regulation, purification, habitat, carbon, health, recreation and social value. For these benefits to be recognised and maintained, the basin must be observed, corrected, updated and accompanied over time.

The River Contract thus becomes the place where basin planning, technical standards, local communities, implementation instruments and finance for nature can converge in an operational strategy.

XXII. An Operational Matrix To Connect River Contract And NbS

To make the relationship between River Contract and Nature-based Solutions operational, the Action Programme should be built around a matrix capable of connecting critical issues, ecosystem functions, solutions, responsibilities and monitoring. The matrix should start from the pressure to be addressed, such as diffuse pollution, hydromorphological alteration, flood risk, drought, habitat loss, impermeabilisation or conflict over uses, and associate that pressure with the ecosystem function to be regenerated, for example infiltration, storage, purification, ecological continuity, shading, thermal regulation or groundwater recharge.

On this basis, the most coherent solution should be selected, which might be a buffer strip, a wetland, a rain garden, bank renaturalisation, a floodable park, riparian reforestation, a conservation agriculture practice or a creek daylighting intervention. The matrix should then clarify the scale of intervention, distinguishing site, network, sub-basin, basin or wider area, and identify the responsible actor, which may be public, private, partnership-based or community-based.

The implementation model should be defined with equal precision, since an NbS may be implemented through public procurement, a voluntary agreement, a concession, a public-private partnership, a collaboration pact, payment for ecosystem services or an agri-environmental measure. A central element should be the care plan, with responsibilities, frequencies, resources, competences and intervention methods. Hydrological, ecological, social, economic and landscape indicators should accompany this plan, together with a monitoring system connected to the National Platform and, where possible, citizen science activities. The matrix should finally include an adaptation procedure, namely the way in which monitoring results redirect actions.

Organised in this form, the Action Programme would no longer be merely a list of interventions, but an adaptive management device.

XXIII. Conclusion

The River Contract should not be forced into the category of Nature-based Solutions as if it were a single natural work, because its nature is different and more strategic. It can be understood as the device that makes NbS operational, durable and verifiable at basin scale, connecting the ecosystem dimension of the river with the institutional, social, economic and managerial dimensions.

The river provides the ecosystem basis, while NbS provide the technical repertoire. UNI, ISO, EN 18140, CEN/CWA and IUCN standards and references offer terminology, criteria, indicators and evaluation principles. The OECD document shows that NbS must be integrated into basin management plans and Programmes of Measures, associated with real territorial pressures and supported by governance, finance and monitoring. The WRI framework helps select solutions according to risks, territorial typologies and functions. EIP-AGRI shows the crucial role of agriculture and small basins. The European report on public procurement clarifies that, without administrative capacity and appropriate procedures, NbS remain difficult to implement. NATURVATION shows that mainstreaming NbS requires public mandate, intermediaries, partnerships, co-financing, data, monitoring and competences. Casale and Rinaldi allow the River Contract to be placed within a broader theory of implementation, in which the basin is the privileged unit of action and the River Contract becomes an operational device for territorialising objectives, coordinating actors and making portfolios of interventions implementable. Literature on River Contracts finally reminds us that the signature of the contract is not enough, because real participation, place-making, responsibility and continuous care are needed. In Italy, with Ministerial Decree No. 190/2025 and the national document on the monitoring of River Contracts, the

River Contract is placed within a stable infrastructure of guidance, coordination, data collection and evaluation [12], [18], [25], [27].

Basin care concerns water, soil, biodiversity, landscape, communities and local economies. The effectiveness of the River Contract does not depend only on the capacity to design interventions, but on the possibility of keeping them alive, adapting them, measuring them, financing them and making them an ordinary part of territorial governance.

The River Contract can therefore be considered the instrument through which Nature-based Solutions cease to be isolated interventions and become a permanent practice of basin care, capable of integrating hydraulic safety, ecological regeneration, community well-being, institutional responsibility, administrative capacity, financial capacity and climate resilience.

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