CONEXUS

Cost-benefit analysis (CBA) for valuing NbS in CONEXUS pilot projects

This factsheet summarizes the results of a Cost-Benefit Analysis (CBA) undertaken to evaluate the Social Return on Investment (SRI) through the Net Present Value (NPV) and Internal Rate of Return (IRR) of three CONEXUS pilot projects: the Urban Allotment Network (Barcelona, Spain), Francia Street Raingardens (San Martín, Buenos Aires, Argentina), and Green Interventions in Valddoco (Turin, Italy).

All public interventions aim to increase social benefits, encompassing a wide range of direct and indirect impacts on specific groups or societies. These impacts are multidimensional, ranging from observable and measurable benefits, such as increasing job opportunities or disposable income, to more subjective ones, such as enhancing social cohesion, mental health, or a sense of belonging. Economic considerations of these impacts are fundamental to the adoption of Nature-based Solutions (NbS), to ensure their fair evaluation in traditional analyses, feasibility studies, and business case evaluations. A team led by the Municipality of General San Martín, the University of Buenos Aires, and CONICET explored different economic valuation techniques. It helped to monetize less tangible outcomes. By doing so, the hidden value of NbS was revealed, potentially making them more attractive to public decision-makers and investors.

Challenges

1. Valuing NbS projects involves assigning monetary values to ecosystem services that do not have a market price.
2. NbS projects and their ecosystem services differ significantly between cases, so the CBA approach must be tailored for each one.
3. Valuing NbS projects requires using very different assessment methods, such as evaluating regulatory and cultural ecosystem services.

Nature-based Solutions and the Problem of Economic Valuation

NbS economic valuation faces a double challenge. First, there is the common challenge of valuing subjective social benefits of public interventions, which values can significantly differ across individuals and communities. Secondly, the challenges in conducting CBA for NbS projects are related to the complexity of valuing ecosystem services (ES), mainly due to the absence of market prices for some of them. There are often market prices for ecosystem goods, such as wood, as they are traded commodities. Economic values for non-marketed services, such as clean air or biodiversity protection, are less well understood. However, not including the values of non-marketed services can introduce a bias towards well-known, standardized values.

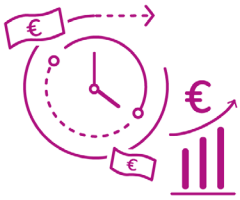
Thus, NbS assessment requires a combination of conventional valuation methods and ecosystem service valuation. Despite encountering challenges, such as information gaps, theoretical complexities, and ethical considerations in economic valuation, estimating the economic value is increasingly becoming a standard practice in evaluating any nature-based project. Valuing NbS reflects diverse purposes, including demonstrating economic value; project and policy appraisal and impact assessment; prioritizing investments; demonstrating 'Value for Money'; informing planning/location decisions; monitoring and reviewing decisions; and environmental accounting (Tinch et al., 2019).

NbS economic valuation offers the advantage of accounting for and comparing the totality of the benefits

Growing attention to valuing NbS reflects diverse purposes

Net Present Value (NPV)

NPV assesses the value of a project by comparing the present value of expected benefits to the costs, determining if the project's benefits outweigh its costs.



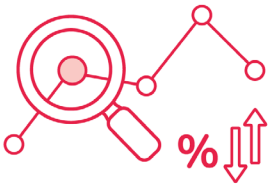
Key message

A positive NPV indicates the project's **benefits outweighs its costs**

Key message

Project IRR > Discount rate
= socially profitable

Internal Rate of Return (IRR)



IRR estimates the annual rate of return a project is expected to generate, given its cash flow. If the IRR is higher than the discount rate, the project can be considered socially profitable.

delivered by different NbS. It also enables less tangible outcomes to be monetized, revealing the hidden value of NbS.

Overall, a key benefit is the ability to aggregate impacts into a homogeneous unit of measurement: money. Monetization is the last step in economic valuation. It is an attempt to measure human preferences for a good or service. It should be noted that the monetary values in NbS project assessments are used to account for benefits rather than represent actual money.

Cost-benefit analysis of three selected CONEXUS pilot projects

To value a range of ecosystem services and deliver co-benefits, CBA studies were conducted for three cases of urban NbS pilot projects, fully executed and thoroughly analyzed: Urban Allotment Network (Barcelona, Spain), Francia Street Raingardens (San Martín, Buenos Aires, Argentina), and Green Interventions in Valldoco (Turin, Italy). These case studies provided insight into economic valuation techniques.

The valuation methodologies and the costs and benefits are assessed differently in each project, considering the NbS types, users, and incremental benefits. Incremental benefits are the benefits added compared to those from the existing situation. Despite the difficulties in obtaining information for valuations for all identified benefits, the assessed benefits were sufficient to verify the socio-economic viability of the projects compared to the investment and maintenance costs.

The CBA was based on the calculation of the Net Present Value (NPV) and Internal Rate of Return (IRR) to understand the Social Return on Investment (SRI). NPV assesses the value of a project by comparing the present value of expected benefits to the costs to determine if the project's benefits outweigh its costs. A negative NPV suggests that the project may not be worth pursuing. IRR estimates the annual rate of return a project is expected to generate, given its cash flow. If the IRR is higher than the discount rate for the project, it can be considered socially profitable. The discount rate is the interest rate or cost of money in a particular place and time.

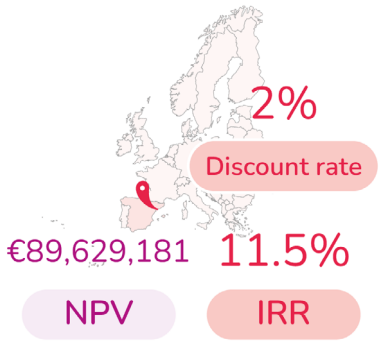
1. Urban Allotment Network, Barcelona, Spain

Barcelona's Urban Agriculture Observatory manages a network of 47 urban allotments, covering 75,826m2 and engaging 1,294 direct users. Some allotments primarily focus on cultivation activities, whereas others offer a more comprehensive range of social activities. The network aims to improve social inclusion and cohesion of marginal groups through activities related to nature. Access to the urban allotments is restricted to registered individual users; the benefits delivered are considered a private good rather than a public one, as opposed to the following two pilot projects assessed. For this reason, the valuation focused on personal, subjective, and objective benefits.

The ecosystem services provided by the green areas of the urban allotments were not included in the valuation because they are not considered incremental. The main socio-economic benefits identified and **valued** were:

1. **Carbon sequestration and storage**
2. **Direct vegetable production**
3. **Subjective benefit (time spent)**
4. Impact on health (physical and mental)
5. Social interaction
6. Soil permeability
7. Plant and animal biodiversity
8. Environmental education
9. Temperature regulation

The Urban Allotment Network was evaluated for a perpetual lifespan (i.e., endless duration), and the discount rate adopted was 2%. The NPV was calculated as €89,629,181, and the IRR was 11.5%, which is a socially profitable project for the discount rate used.



Urban Allotment Network
Barcelona, Spain

2. Francia Street Raingardens, San Martín (Buenos Aires), Argentina

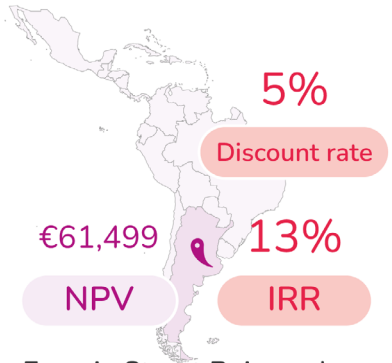
This pilot project was developed for Francia Street as part of a broader initiative to upgrade public spaces in the street. Located in an industrial zone with a nearby informal settlement, the project involved creating a series of linear rain gardens (RGs) designed for water retention, accumulation, and mechanical and biological filtration. These features aim to manage stormwater, reduce flood risk and pressure on the drainage system, and enhance the quality of water discharged into the Río de la Plata by decreasing its pollutant load.

The valuation focused on the incremental ecosystem services provided by the intervention, specifically emphasizing water management. Additionally, increased property values (a private benefit) were included in the assessment because it was possible and feasible to identify the property owners as direct beneficiaries of the RGs.

The main socio-economic benefits identified and **valued** were:

1. **Water quality improvement**
2. **Flood Risk Reduction**
3. **Land value uplift**
4. **Carbon sequestration and storage**
5. **Air quality improvement**
6. **Amenity and aesthetics**
7. Biodiversity increase
8. Temperature regulation

Francia Street RGs were evaluated for a lifespan of 50 years, and the discount rate adopted was 5%. The NPV was calculated as €61,499, which indicates that the project is socially profitable (positive NPV) for the discount rate used. Furthermore, the project's IRR was 13%.



Francia Street Raingardens
Buenos Aires, Argentina

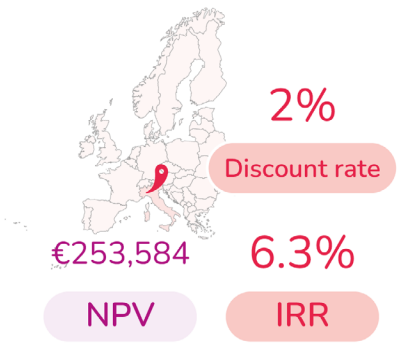
3. Green Interventions in Valdocco, Turin, Italy

In the context of Valdocco Vivibile, a sustainable mobility program for reorganizing vehicles' and pedestrians' circulation, the project focuses on incorporating NbS in a historic neighborhood. The project aimed to improve a well-defined area by working closely with stakeholders and citizens to increase awareness and dialogue on sustainability. Thus, the improvements are public, and the direct beneficiaries cannot be defined straightforwardly. The valuation method was mainly based on the public benefits from the ecosystem services of the implemented NbS, which constitutes the incremental part of the project over the existing gray infrastructure. As explained above, private benefits, such as the increase in property values, were not valued, as they are difficult to assign to direct beneficiaries.

The main socio-economic benefits identified and **valued** were:

1. **Carbon Sequestration and Storage**
2. **Urban temperature regulation**
3. **Environmental education**
4. **Hydrogeological protection (reducing hydraulic risk)**
5. Storm water infiltration capacity (included in Hydrogeological protection for valuation)
6. **Amenity and Aesthetics**

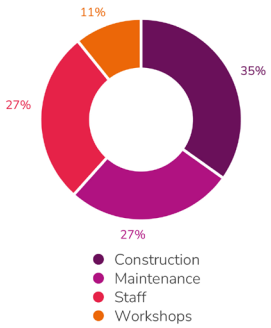
Green Interventions in Valdocco was evaluated for a lifespan of 50 years, and the discount rate adopted was 2%. The NPV of the Green Interventions in Valdocco was calculated as €253,584, indicating that the project is socially profitable for the discount rate. The IRR for this pilot was 6.3%.



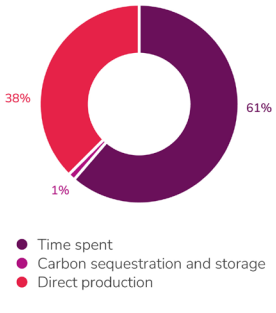
Green Interventions in Valdocco
Turin, Italy

Overview of the cost-benefit analysis of three selected CONEXUS pilot project

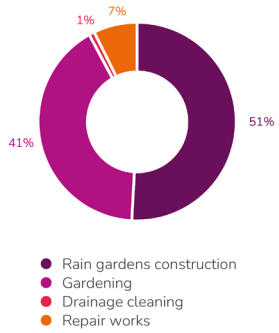
Present value of the costs
Urban Allotment Network



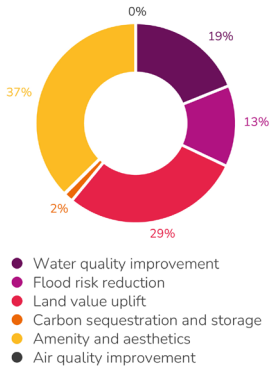
Present value of the benefits
Urban Allotment Network



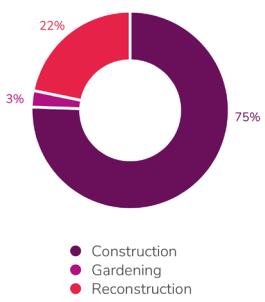
Present value of the costs
Rain Gardens



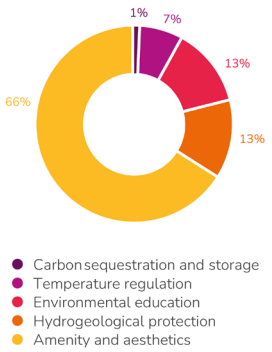
Present value of the benefits
Rain Gardens



Present value of the costs
Green Interventions



Present value of the benefits
Green Interventions



Final remarks

The relative weight of the valorization of the different benefits generated by NbS varies significantly. Some ecosystem services, such as carbon sequestration – typically the main focus of projects outside urban areas – represent marginal value in urban projects. On the other hand, small interventions, in terms of cost, size, or the volume of biomass created, can significantly affect the generation of value associated with benefits derived from cultural ecosystem services. For example, in the case of San Martín, 'Amenity and Aesthetics' accounted for one to two-thirds of the total benefits. In contrast, in the case of Barcelona, 'Time Spent' represented two-thirds of the calculated benefits.

The socio-economic evaluation of projects requires specific assessment standards. Each project has different objectives and beneficiaries, so the variables (e.g., carbon sequestration, air quality) selected for its valuation can vary. The assessed variables were generally chosen based on their relevance to the case. In other words, each CBA was primarily tailored to each particular case.

CBA based on NPV and IRR should only be used to compare projects with the same objectives or beneficiaries. The three pilot projects analyzed proved to be cost-effective in their own right, but the IRR of each project cannot be compared, as they were built in different cities for different purposes. While monetization provides a homogeneous and theoretically "comparable" measure, it should be used cautiously when comparing projects, as the NPV and IRR results are only valid for a specific context. NPV and IRR are the most consistent tools for evaluating the project's cost-benefit relationship. Monetization adds various benefits using the precise and known variables: the costs.

CBA as a tool helped demonstrate the social value created by the benefits of the three NbS interventions studied, even though not all identified benefits could be monetized in the analysis. A more comprehensive evaluation of additional identified benefits would provide a better appreciation of the overall value, potentially reaffirming and even increasing the positive evaluation results monetarily.

Answers found

1. CBA is a crucial tool to demonstrate the social value of NbS interventions
2. CBA is fundamental to creating compelling business cases to promote NbS
3. Regulating ES, like carbon sequestration, often have marginal value in urban projects
4. In small urban interventions, cultural ES tend to play a significant role

References

KOZAK, D. et al. (2020). Blue-Green Infrastructure (BGI) in Dense Urban Watersheds. The Case of the Medrano Stream Basin (MSB) in Buenos Aires. Sustainability, 12(6), pp. 21-63. link

KOZAK, D. et al. (2022). Implementación de Infraestructura Azul y Verde (IAV) a través de mecanismos de captación de plusvalía en la Región Metropolitana de Buenos Aires: El caso de la Cuenca del Arroyo Medrano. link

ROTBART, D. et al. (2024). Guidance on valuation of NBbS. Cost-benefit analysis of selected pilot projects. Deliverable 5.2 Report, H2020 CONEXUS.

TINCH, R. et al. (2019). Economic valuation of ecosystem goods and services: a review for decision makers, Journal of Environmental Economics and Policy, 8:4, 359- 378.

WILD, T. et al. (2024). Valuation of urban nature-based solutions in Latin American and European cities. Urban Forestry & Urban Greening, p. 128162; doi.org/10.1016/j.ufug.2023.128162. link

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This project has received funding from the Europeans Union's Horizon 2020 research and innovation programme under grant agreement no. 867564

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San Martín

December 2024. Texts by Demián Rotbart, Daniel Kozak, Mariana Giusti, Esteban Otto Tomasz & Hayley Henderson. Edition by M. van Lierop & K. Enu, design and layout by S. Chan, TUM. Photos by Demián Rotbart , Barcelona Regional & Mariana Giusti.