Green Infrastructure Evaluation
Benefit Intensity, Benefit Profile and Benefit Dependencies

Project area: Evaluation of stormwater management strategies
Intended readership: Practitioners, academics and other interest groups

Green Infrastructure can provide multiple benefits across a wide range of scales and to various beneficiaries. We propose three new concepts; **Benefit Profile, Benefit Intensity** and **Benefit Dependency,** to better characterise and co-design stormwater facilities which utilise Green Infrastructure.

Figure 1. A Green Infrastructure project in East Lents, Portland, Oregon

A better understanding is required of the wider usefulness of Sustainable Urban Drainage Systems (SuDS) which incorporate Green Infrastructure and vegetated surfaces.

- Firstly, Green Infrastructure benefits are *context-dependent*. The significance of a few square metres of tree cover in a densely populated urban area with little green space area might be much more than in a townscape which already has extensive green areas.

- Secondly, *trade-offs* may occur between different benefit categories for a range of installation types, as illustrated in *Hoang and Fenner* (2014) and *Demuzere et al.,* (2014).

- Thirdly, many of the added benefits are *incremental* and need to be assessed in relation to the level of similar services which pre-existed in each specific location, and the rate they develop over time.

- Finally, monetising benefits is always method dependent, fails to reflect complex interactions between benefits, and where value transfer is adopted often gives rise to large uncertainties and differences with the circumstances in the original study. Such approaches also ignore spatial and temporal distributions.

Benefit profile, benefit intensity and benefit dependencies

Our three concepts aim to compare across a range of potential benefits to establish the relative contribution each can deliver in specific local circumstances and individual site characteristics.

- **Benefit profile:** displays a set of normalised impacts and their *relative contribution* to the area of interest, in the form of a bar chart comparing a Green Infrastructure scenario and a reference scenario.

- **Benefit intensity:** shows the *spatial extent* and *cumulative distribution* of benefits over space either as a series of overlay layers or overall contours of the total benefit surface.

- **Benefit dependency**: analyses the *complimentary and exclusivity* of impacts across categories.

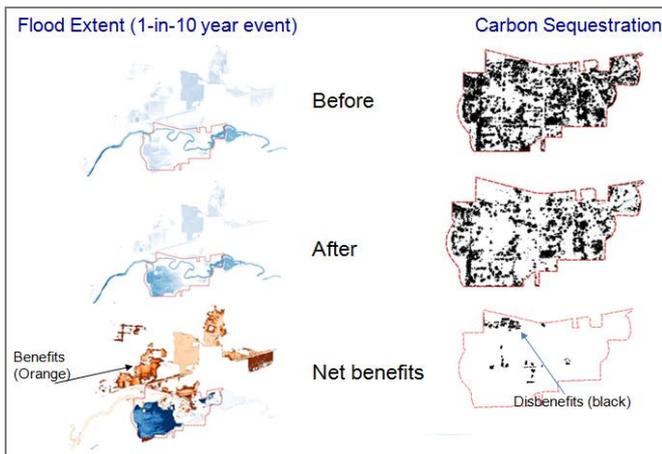## East Lents Flood Restoration Project, Portland Oregon

Figure 2. Example of the distribution of flood mitigation and carbon sequestration benefits in a case study in Portland
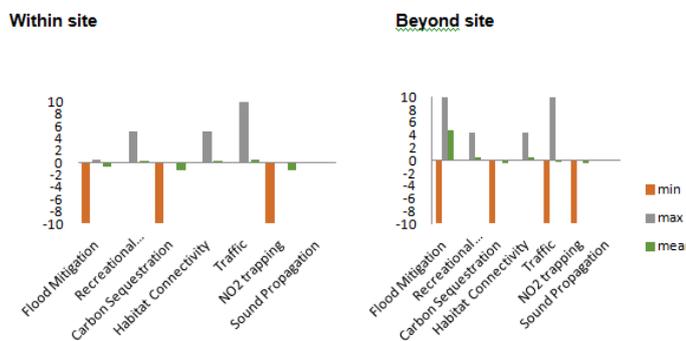

*Figure 3. **Benefit profile** comparing normalised benefits within and beyond the site*

Other sources of information:

Hoang L**,** Fenner R.A. (2015) System interactions of flood risk strategies using Sustainable Urban Drainage Systems and Green Infrastructure. Urban Water Journal.

Hoang L., Fenner R.A (2015) Towards a new approach for evaluating the multiple benefits of stormwater management practices. Journal of Flood Risk Management.

Case study

These concepts could be integrated in an analysis framework that compares a reference condition and a Green Infrastructure condition.

These concepts have been applied and demonstrated in a case study in Portland, which compares the before and after conditions of a floodplain restoration project.

This case study shows that:

- Benefits and disbenefits occur unevenly over the project site (and at different times) (Figure 2)

- The **benefit profile** shows flood mitigation, habitat connectivity and recreational accessibility are the dominant benefits of the project (Figure 3)

- The spatial accumulation of benefits is shown as a varying **benefit intensity** across the site (Figure 4)

- There are **benefit dependencies** across the benefit categories, for example NO_2 trapping and carbon sequestration are both dependent on the vegetation cover

Implications and Future Research

Overall, the concepts of benefit intensity, benefit profile and benefit co-dependencies help highlight the relative significance of the benefits, as well as potential for prioritising and co-designing the benefits from the outset of project planning. They can help identify the key beneficiaries and agencies to be involved.
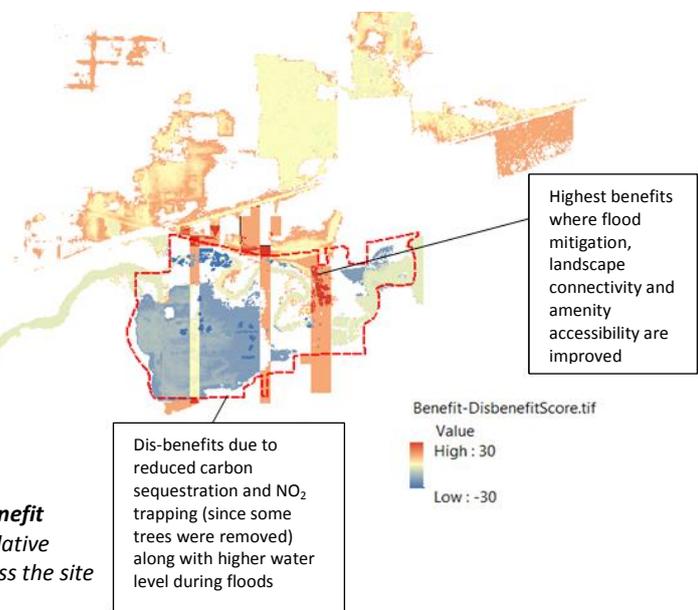

Highest benefits where flood mitigation, landscape connectivity and amenity accessibility are improved

Dis-benefits due to reduced carbon sequestration and NO_2 trapping (since some trees were removed) along with higher water level during floods

*Figure 4. Example of **benefit intensity** showing cumulative benefit distribution across the site*

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