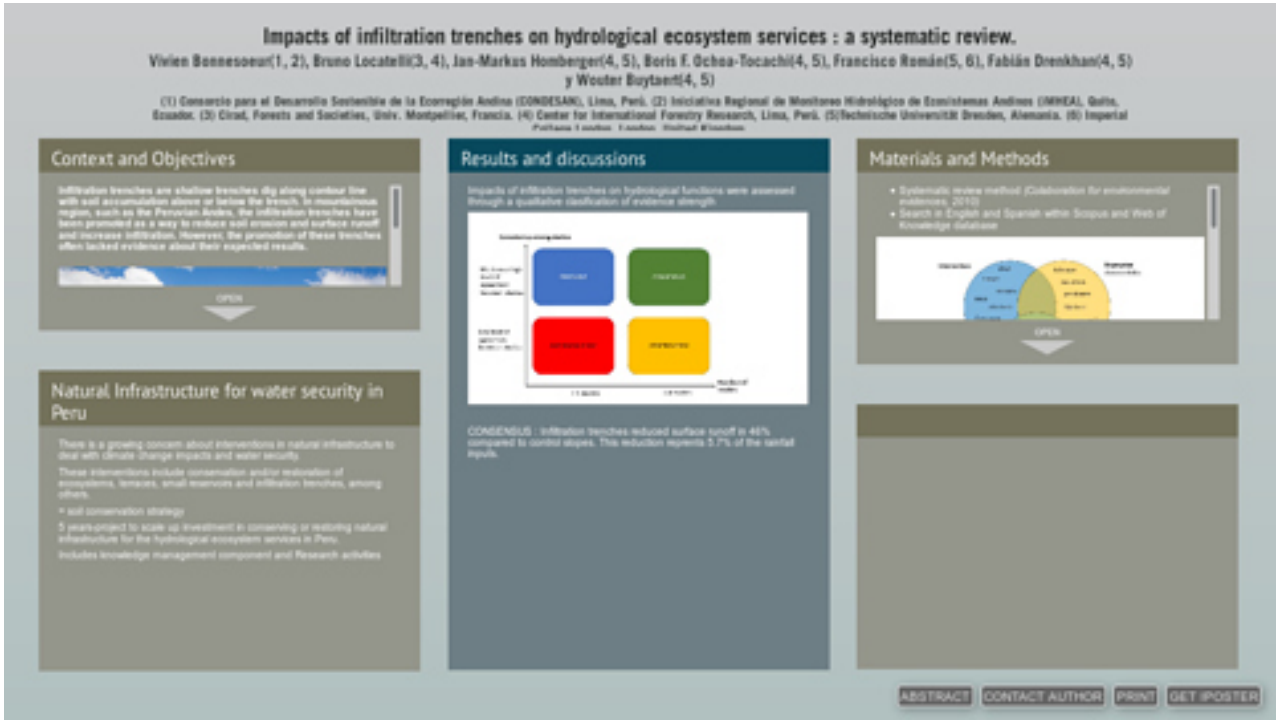
Impacts of infiltration trenches on hydrological ecosystem services : a systematic review.



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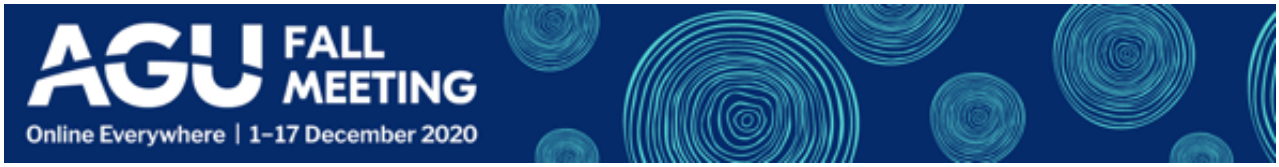
PRESENTED AT: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CONTEXT AND OBJECTIVES

Infiltration trenches are shallow trenches dug along contour lines with soil accumulation above or below the trench. In mountainous regions, such as the Peruvian Andes, infiltration trenches have been promoted as a way to reduce soil erosion and surface runoff and increase infiltration. However, the promotion of these trenches often lack evidence about their expected results.

Infiltration trenches in Piuray watershed, Cusco, Peru.

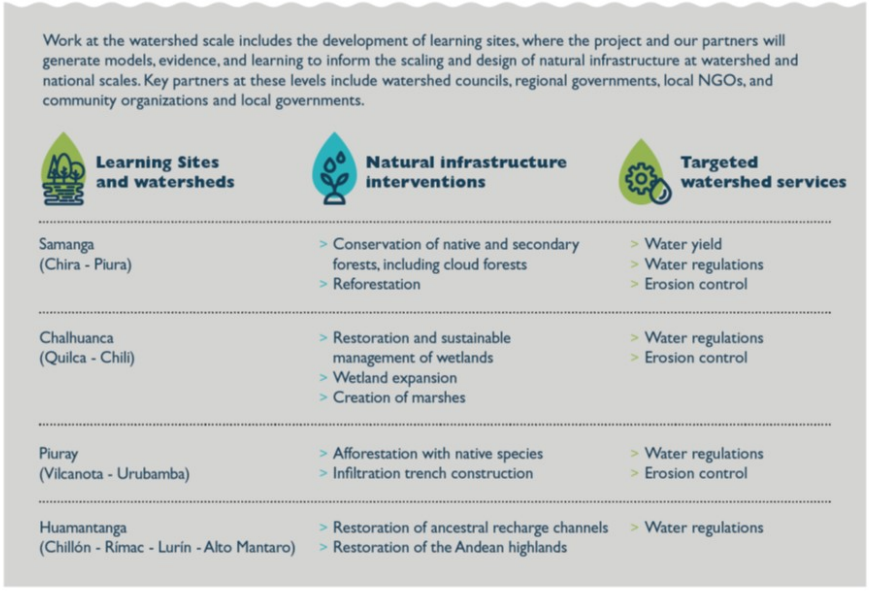
It is important to consider sound knowledge available about the operation and maintenance of the trenches to maximize the hydrological services and reduce their negative impacts. Therefore this study proposes to synthetize the available evidence on the impacts of infiltration trenches across mountainous regions of the world.

NATURAL INFRASTRUCTURE FOR WATER SECURITY IN PERU

There is a growing interest in interventions in natural infrastructure to deal with climate change impacts and water security. These interventions include conservation and/or restoration of ecosystems, terraces, small reservoirs and infiltration trenches, among others.

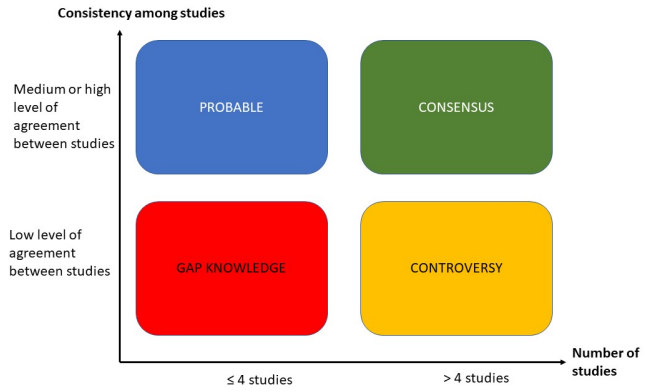
This study has been funded by the ***Natural Infrastructure for Water Security*** project in Peru (NIWS, 2017-2023). This project aims at scaling up investments in conserving and restoring natural infrastructure for hydrological ecosystem services in Peru.

Furthermore, NIWS builds on the development and dissemination of sound knowledge (hydrology, ecology, social sciences, etc) and process understanding in order to support local decision-making in close collaboration with multiple stakeholders (national and regional governments, water service providers...).



RESULTS AND DISCUSSIONS

Impacts of infiltration trenches on hydrological functions were assessed through a systematic review using a qualitative assessment of the level of evidence:



CONSENSUS : Infiltration trenches reduced surface runoff by 46.4% [CI=43.0%;49.5%] compared to control slopes at plot scale. This reduction represented 5.7% [CI=5.0%;6.4%] of the rainfall inputs.

CONSENSUS : The reduction of surface runoff was higher for slopes with natural land cover than for those with crop cover.

KNOWLEDGE GAP: It is surprising that only two studies have considered the impact of "infiltation trenches" on ... infiltration. A reduction in surface runoff could be interpreted as an increase in infiltration. However, ponded water in the trenches can also evaporate.

PROBABLE : The trench design should be adjusted to the infiltration capacity of the soil. Small trenches would be adequate for soils with high permeability.

CONSENSUS : Infiltration trenches significantly reduced soil erosion by 73% [CI=69.6%;76.0%]. This represents a soil loss reduction of 4.8 t/ha/yr [CI=3.9; 5.6]

PROBABLE : Two complementary mechanisms might explain this high soil loss reduction. First, the reduction in surface runoff should reduce erosion between trenches and downslope. Second, a part of the sediment can be trapped in the trenches.

KNOWLEDGE GAP: All the studies dealt with laminar erosion. The impact of infiltration trenches on other forms of erosion (gullies, mass movements) remains largely unknown.

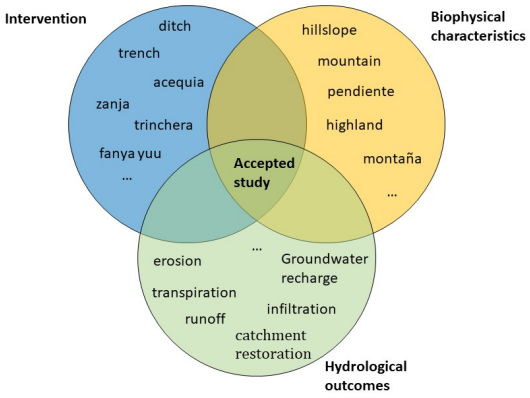
KNOWLEDGE GAP: The impacts of infiltration trenches on soil moisture were unclear, according to the four studies covering this topic. An explanation for that might be that trenches affect soil moisture only at a very short distance.

PROBABLE : Infiltration trenches indicate short-term evolution of their hydrological functions. Some studies showed an increase in soil loss just after the trenches were dug. Other studies found that trenches effectiveness reduced with time due to their filling by sediments in less than 5-10 years.

KNOWLEDGE GAP: Most studies were at plot scale. Watershed-level effects of trenches are therefore difficult to estimate.

MATERIALS AND METHODS

- Systematic review method *(Colaboration for environmental evidences, 2010)*
- Search in English and Spanish within Scopus and Web of Knowledge database



Search terms and criterion for study inclusion

- 57 studies - 80 sites analysed

Global distribution of analysed studies

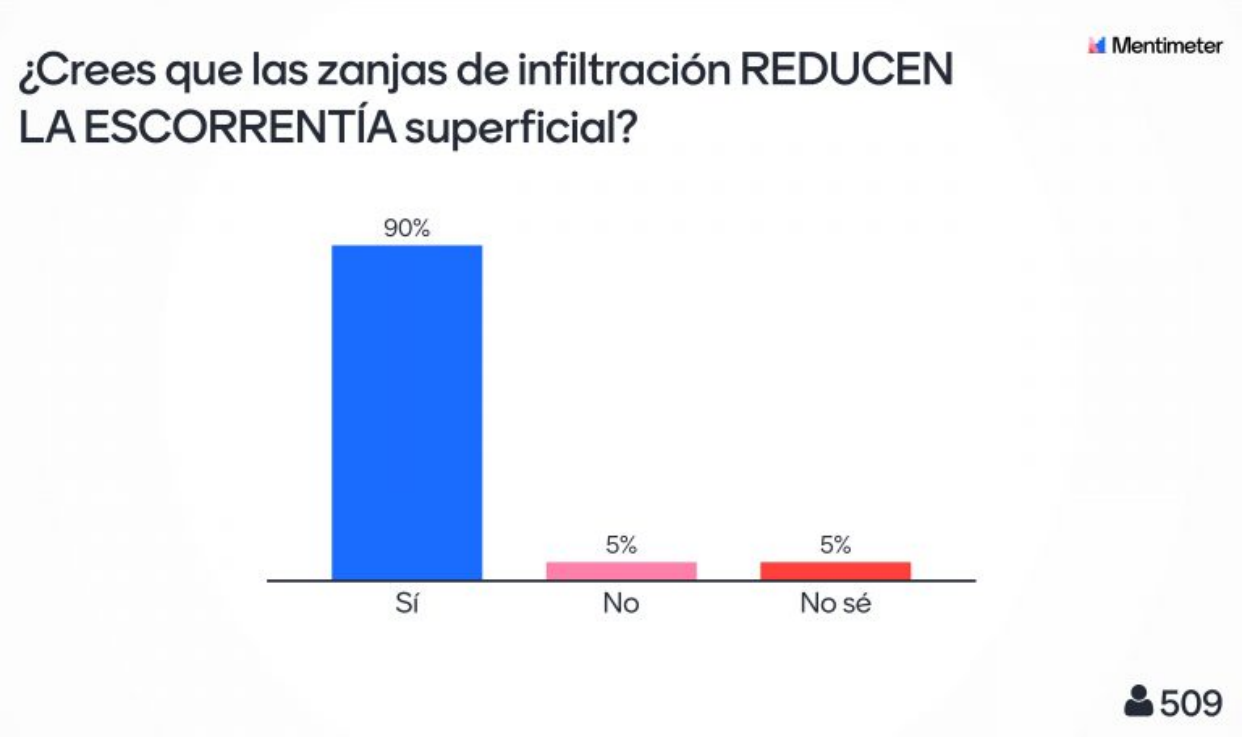
- Meta-analysis methods were used to assess the impact of infiltration trenches on surface runoff and soil laminar erosion
- Narrative synthesis was used when studies provided insufficient statistical metrics

SCIENTIFIC EVIDENCE AND LOCAL PERCEPTION

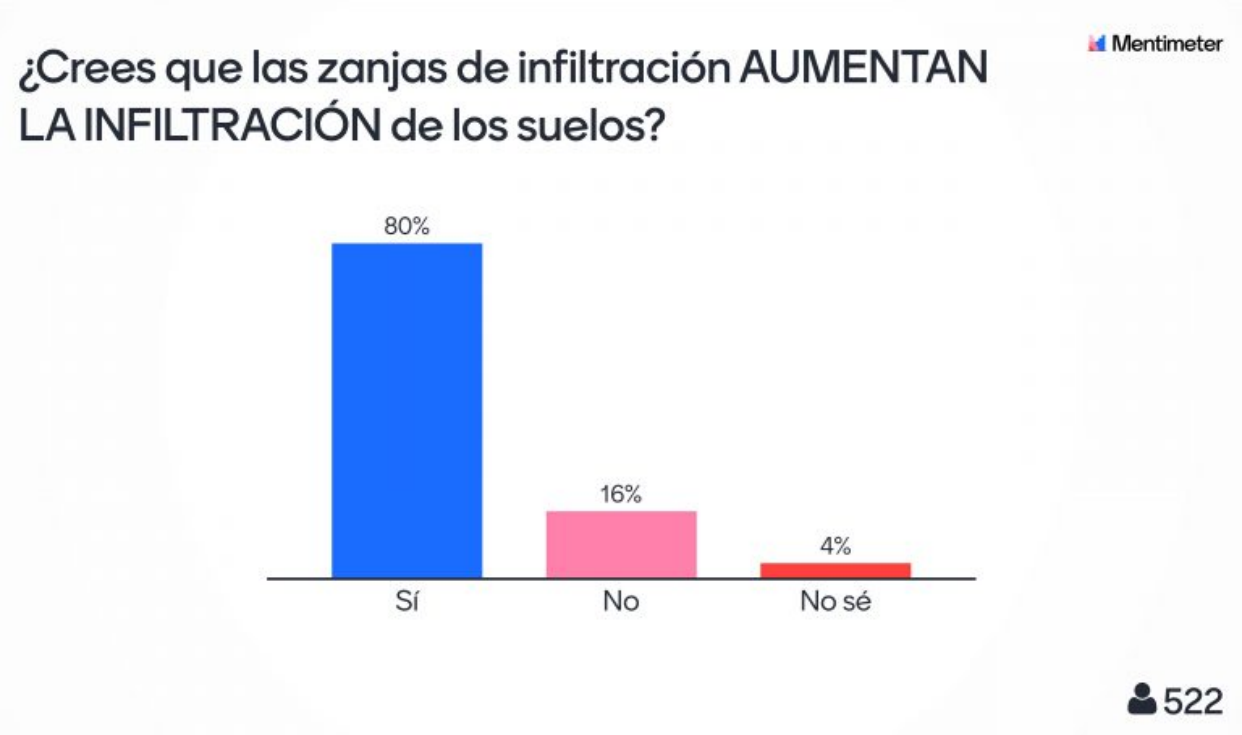
On 20th of may 2020, the results from our systematic analysis were then presented to a broader public during an online webinar (~900 participants from the Andean countries and mostly Peru). Therefore, the participants provided their perceptions on several key questions about infiltrations trenches which are presented as follows.

During the webinar, and before presenting the main results, the audience was asked to provide their perception about the impact of infiltration trenches on some hydrological functions, through a vote-platform. The comparison with academic evidence (https://www.forest-trends.org/blog/zanjas-de-infiltracion-evidencia-vs-percepciones/) is presented below.

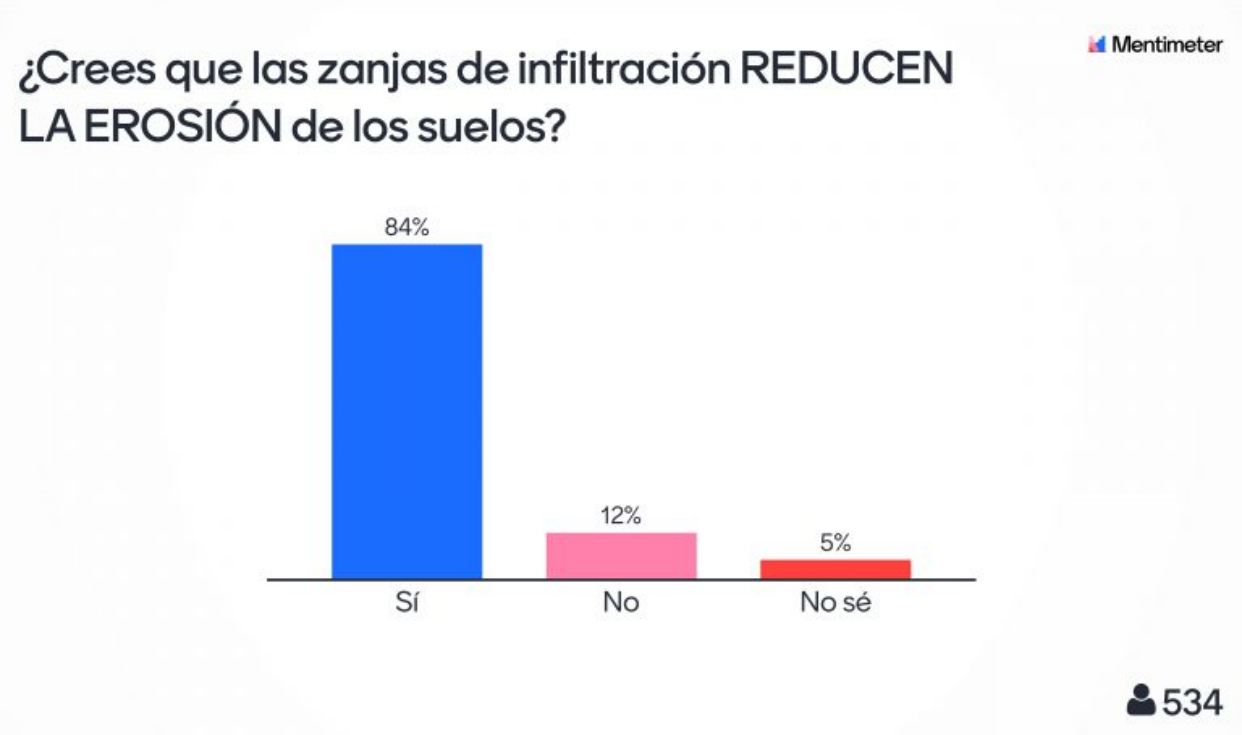
- 90% of the participants believed that infiltration trenches reduce surface runoff, in agreement with academic evidences.



- 80% of the participants believed that infiltration trenches increase soil infiltration. This stands in contradiction to the academic evidence, where a gap knowledge had been found



- 85% of the participants believed that infiltration trenches reduce the soil erosion, in agreement with academic evidences on laminar erosion.



ABSTRACT

- There is a growing concern about interventions on natural infrastructure to deal with climate change impacts and water security. These interventions include forestation, terraces, small reservoirs and infiltration trenches, among others. Infiltration trenches are shallow trenches dig along contour line with soil accumulation above or below the trench. In mountainous region, such as the Peruvian Andes, the infiltration trenches have been promoted as a way to reduce soil erosion and surface runoff. However, the promotion of these trenches often lacked evidence about their expected results.
- It is important to consider sound knowledge available about the operation and maintenance of the trenches to maximize the hydrological services and reduce its negative impacts. As far as we know, there is no synthesis of the hydrological impacts of infiltration trenches. Therefore this study proposes to synthetize the available evidence of the impacts of infiltration trenches across mountainous regions of the world with systematic review and meta-analysis methods.
- 57 studies (80 different sites) from 12 countries have been synthetized. Most of the studies were at the plot level and a few studies have been carried at the watershed level (streamflow measured).
- There were not enough studies available to conclude whether infiltration trenches increased soil infiltration or not. However, infiltration trenches significantly reduced surface runoff and soil (laminar) erosion.
- To conserve and restore natural land cover may provide higher hydrological benefits than infiltration trenches with less disturbance for the ecosystems and lower long-term maintenance cost.

REFERENCES

Locatelli B., Homberger JM, Ochoa-Tocachi BF, Bonnesoeur V., Román F., Drenkhan F., Buytaert W., 2020. Impactos de las zanjas de infiltración en el Agua y los Suelos de los Andes: ¿Qué sabemos? Resumen de políticas, Proyecto “Infraestructura Natural para la Seguridad Hídrica”, Forest Trends, Lima, Perú.