LIFE CERSUDS
LIFE15/CCA/ES/000091

Project summary

Castellón, 28 november 2016

www.lifecersuds.eu

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Contents

1. Project description

LIFE CERSUDS is a demonstration project that puts into practice, evaluates, and disseminates sustainable urban drainage systems (SUDS) in a context in which such systems are new or little known. It constitutes an innovative project as it incorporates ceramic material of low commercial value as permeable flooring that can be readily replicated in similar geo-economic areas.

2. Project objectives

The main objective of LIFE CERSUDS is to enhance city adaptability to Climate Change and to promote the use of green infrastructures in urban planning by developing and implementing a demonstrator consisting of a sustainable urban drainage system (SUDS) with low carbon emissions for refurbishing urban areas. The SUDS will consist of a permeable surface whose skin is made up of an innovative system with a low environmental impact, based on the use of ceramic tiles of low commercial value. The demonstrator will have the necessary and sufficient dimensions to validate its technical and economic feasibility.

This general objective may be broken down into the following specific objectives:

- Reducing floods from torrential rains by increasing permeable surfaces in the cities.
- Reducing run-off volumes and flow rate surges that reach the collector network and consequently the treatment station or receiving facility.
- Recovering the water stored during the rainfall period for use in periods of drought.
- Integrating rainwater treatment into the urban landscape.
- Protecting water quality, reducing the effects of diffuse pollution and thus avoiding problems in water treatment facilities.
- Lowering CO_2 emissions relating to the manufacture of paving materials, as the material used for this purpose is in-stock ceramic material of low commercial value.
- Providing a quality aesthetic finish, preventing pools from forming and enhancing street comfort and safety in time of rain.
- Developing a ceramic sustainable drainage system with greater environmental efficiency for urban areas.
- Demonstrating that the ceramic sustainable drainage system is suitable for refurbishing areas with light vehicular and pedestrian traffic, enabling better rainwater management in areas with certain geo-economic conditions.
- Reducing the amount of ceramic material of low commercial value currently stored at companies, providing it with a new commercial use and increasing industry profits.
- Assuring transferability after the conclusion of the project through training activities and the development of a commercial plan for the solution aimed at both stakeholders and target users of the solution, and at raising public awareness and replicability.
- Generating detailed technical documentation for replication in other cities of permeable floorings based on the principles of the demonstrator.

3. Actions and resources used

Figure 1 shows the project actions and their interrelationships:

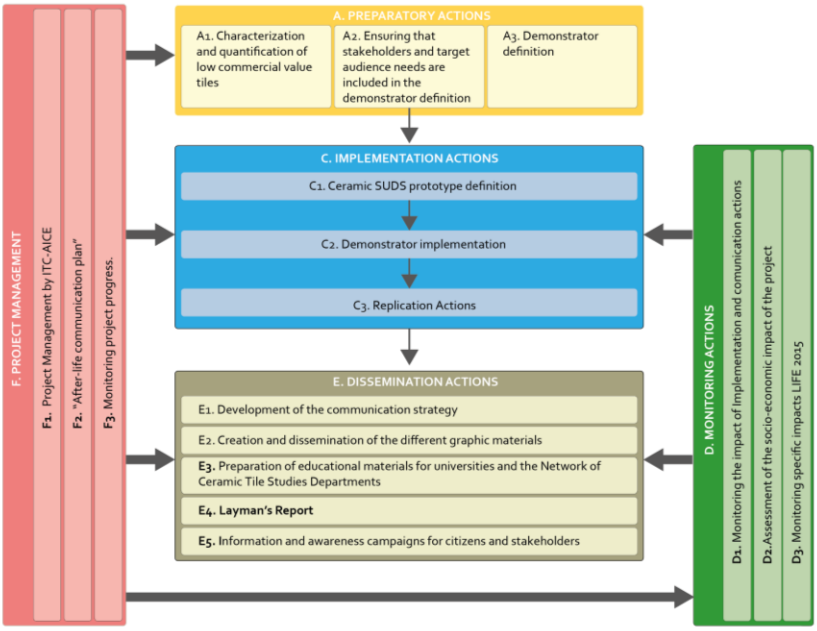

Figure 1. Project structure

The project includes the participation of the stakeholders required to achieve the proposed objectives. The consortium comprises the following 7 partners:

- ITC-AICE, the project coordinator, a Research Centre with experience in the application of ceramics in urban development.
- UPV, the Polytechnic University of Valencia. The project includes the participation of the University Research Institute of Water and Environmental Engineering (IIAMA), experts in water management and sustainable urban drainage systems.
- The TOWN COUNCIL OF BENICASSIM, a town in Castellón especially sensitive to the risks of Climate Change.
- CHM INFRAESTRUCTURAS, a construction company with wide experience in its field, particularly focused on R&D and innovation.
- TRENCADIS DE SEMPRE, a company with a markedly innovative character and environmental

sensitivity.

- CCB, Centro Ceramico Bologna, Italy, a Centre that has worked for 40 years fostering cooperation between companies, the territory, and the university.
- CTCV, Centro Tecnológico da Cerâmica e do Vidro, Portugal, devoted to the promotion of innovation and the development of technical and technological capabilities of industries and services in the context of the living environment.

In addition, a Monitoring Committee has been established, made up of several organisations from the Regional Work Group created in the E2STORMED project (www.e2stormed.eu), which allows its experience, needs, and concerns to be incorporated in project definition and monitoring.

4. Expected results

- A permeable flooring that can reduce surface run-off volumes by almost 90%. This results in smaller volume flows towards the collector network, thus making it more resilient to floods.
- A replicable demonstrator with rainwater storage capacity for subsequent water recovery for use as irrigation water in the upkeep of public spaces in periods of drought.
- Reduction of diffuse pollution and amelioration of water quality compared to those of traditional systems. Pollutant removal efficiencies are expected to be over 70% for hydrocarbons, over 50% for phosphorus, over 65% for nitrogen, and over 60% for heavy metals (Wilson, S et al., 2004)
- Substantial abatement of CO_2. Draining concrete paving (a 5-cm layer) over the entire surface of the demonstrator (3,000 m^2) would involve manufacturing emissions of 50,000 kg CO_2 eq. Instead, in-stock stored ceramic material of low commercial value will be used, producing a minimal CO_2 emission, as it has already been made.
- A replicable demonstrator of 3,000 m^2 permeable urban flooring, using 408 tonnes of ceramic material of low commercial value.
- Technical documentation of the demonstrator and of the results obtained to help local and regional authorities throughout Europe include this type of green infrastructure in their urban development plans.
- Instructional material on this type of system (SUDS) for inclusion in the educational materials of the six European ceramics studies departments of Architecture (Spain, Germany, and England).
- Increased surface area of the green spaces in the demonstrator area irrigated by the water stored in the rain tank.
- Enhanced safety on reducing the level of flooring slipperiness to a standard UNE-EN 12633 Pendulum value between 45 and 65.
- Reduction of the heat island effect owing to the evaporation of water accumulated in the subsoil.

5. Targeted climate problem

LIFE CERSUDS supports a local initiative that provides greater resilience to Climate Change, decreasing vulnerability by lowering the risk of flooding by reducing the generation of surface run-off at source and the negative effects of periods of drought by installing an underground rain tank fed by the run-off filtered and handled by the permeable flooring.

The targeted climate problem is one of the EU’s top climate priorities. Climate change in Spain will be embodied by a general trend towards higher temperatures and lower rainfall, giving rise to the following effects (Ministry of Agriculture, Food, and Environment, National Plan for Adaptation to Climate Change, PNACC):

- General reduction of available water. Previous estimations for the whole of Spain – with a 2030 horizon, considering a temperature rise of 1ºC and drop in rainfall of 5% – indicate reductions of 5 to 14% in water contributions, which could rise to 20–22% for century-end scenarios.

- Special incidence is expected in arid and semi-arid zones (about 30% of the Spanish national territory), where water contributions could drop by 50%.

- Hydrological variability will increase in the Atlantic river basins, while in the Mediterranean and inland river basins, the greater irregularity of the rainfall pattern will lead to greater irregularity in the pattern of torrential or flash water surges and falls.

Although the various climate change scenarios for Spain in general, and for the Mediterranean in particular, foresee reductions in average rainfall, they also foresee increased torrential rainfall. This means fewer rainfall episodes per year, but greater rainfall intensities, thus entailing greater risk of drought (fewer resources) while simultaneously raising the risk of torrential episodes and inundations.

To better manage the problem of water scarcity (drought) or surplus (flooding) in urban settings, systems must be put in place that allow water storage for subsequent recovery to palliate the former, while mitigating or reducing rapid hydrological response in the case of torrential rain events in order to have more flood-resilient systems. Sustainable Urban Drainage Systems and permeable floorings, in particular, help achieve these objectives. In rainfall periods, **they provide lower surface run-off volumes** as they foster infiltration into the underlying soil while concurrently temporarily storing the surplus water in the porous structure of the base and sub-base of the system. This leads to smaller run-off volumes to the system end-point, and shorter response time, and hence lower volume flow surges. On the other hand, the stored water surplus that does not end up overflowing into the collector network or receiving facility can be stored in small buried storage tanks for subsequent recovery for use in irrigating gardens or cleaning streets, reducing the use of mains water.

In the case of Benicassim, these problems of droughts and torrential rains are particularly clear in the street where it is intended to locate the demonstrator. The photo in Figure 2, taken in August 2008, shows the flooding in the street where the demonstrator is to be built after a torrential episode in summer. The impermeability of the paving, together with the absence of an appropriate drainage system (scuppers), fosters surface run-off. This situation is frequent along the Mediterranean seaboard when convective rain episodes occur. The arising great downpours (exceeding 50 mm/h) in short periods of time generate large run-off volumes that cannot be adequately handled when the existing drainage system is ineffective and incapable of carrying the arising flow volume surges. In addition, when this problem occurs in towns with an orography like that of Benicassim, the problem is aggravated. The town’s topographic profile perpendicular to the sea has large slopes in areas farther from the coastline, which decrease as they advance towards the coast. The result is a rapid build-up of the run-offs in the low part of the municipality where, because of the interference of the sea, the drainage systems are hard put to evacuate sudden, heavy cloudbursts. In view of this situation, the implementation of a permeable flooring clearly mitigates these problems as it drastically reduces surface run-off.

Figure 2. Flooding in Calle del Torreón. August 2008

6. Other environmental benefits

One of the problems that the LIFE CERSUDS project addresses relates to climate change mitigation measures by reducing the environmental impacts of the CO_2 emissions stemming from the manufacture of paving materials. This reduction is obtained by using ceramic tiles originally manufactured for other purposes, currently stored at tile companies (Figure 3), with few prospects of commercial use owing to changes in consumer preferences, which have decreased the product value perceived by the user. Finally, the performance of the original functions of the soil will be fostered by installing a permeable flooring that will allow better use of natural resources.

Figure 3. Stock of ceramic material with low commercial value

The collected data in the ceramic sector in Spain in the frame of this project is about 5,6 milion square meters.

Based on these data, relating to red-body and white-body floor tiles and porcelain stoneware tile, and using the proposed solution, an estimated surface could be covered with permeable flooring of over 600,000 m^2, in turn reducing the surface area occupied at the tile companies by these stocks and the costs stemming from their maintenance and storage.

Regarding the reduction of environmental impacts, the use of local materials – understood as those whose distance from the supply point to the use point is 200 km or less – as permeable flooring decreases the environmental impacts relating to transportation, involving both the impacts of fossil fuel use (air emissions) and those of infrastructures and related transport networks (occupation of the soil, noise, air pollution, or loss of biodiversity and ecosystems).

7. Solution replicability

LIFE CERSUDS is a readily replicable project because it will engage all the stakeholders needed for its implementation and the necessary documentation and procedures will be generated to enable authorities to incorporate and integrate these measures in their CC adaptation policies for rapid replication in other localities with similar geo-economic characteristics.

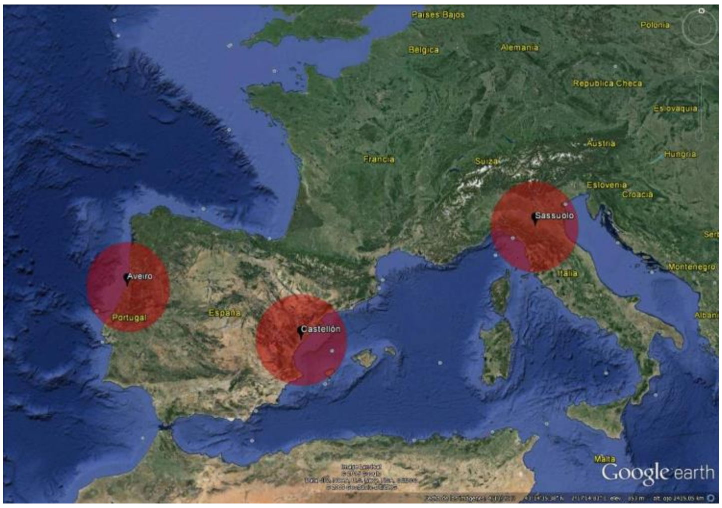

Imagen 4. Zonas de replicabilidad

With regard to addressing the potential replicability of the project, countries with ceramic clusters similar to the Spanish ceramic cluster, which can foster the use of local materials, have been considered, an action radius of 200 km from supply point to use point being determined for each cluster, as shown in Figure 4.

The design of the proposed demonstrator in the LIFE CERSUDS project can be applied in places with similar industrial characteristics. According to Eurostat data, in the case of Italy, the ceramic district, located in Sassuolo, manufactures over 80% of Italian ceramic tile production, producing 369 M m^2 as top European producer, and adaptation of this type of permeable flooring would be immediate. Another ceramic district, with a smaller production but also with possibilities of replicating the proposed SUDS, is the Aveiro-Leira region in Portugal, which produces 43 M m^2.

8. Pre-industrial scale of the demonstrator

The size of the demonstrator corresponds to the scale minimal functional unit of the city, in order to accurately determine the response to technical, economic, and social needs, with a view to facilitating its application on larger urban scales. The demonstrator will be installed in Benicassim, Spain. The space foreseen, while awaiting performance of the relevant geo-technical and hydrological studies, consists of a stretch of street with light vehicular and pedestrian traffic in a consolidated urban setting, 300 m long and 10 m wide (3000 m^2), between two crossroads (Figure 5).

Figure 5. Location of the demonstrator

This scale allows addressing and responding to most of the technical requirements (compatibility with existing services and installations networks, etc.) and social use (responding to residents' vehicle traffic, emergencies and supplies, etc.), which usually occur in operations for **renewing** or regenerating public spaces. In addition, with the proposed surface, and as a function of the thicknesses and void index of the flooring base layers, storage volumes could be achieved in the infrastructure of the order of 300–400 m^3. On the other hand, rainfall measurement in Benicassim indicates a return period annual maximum daily rainfall over 25 years in the range of 160 mm. On the proposed surface that means a rainfall volume of 480 m^3. Consequently, for the maximum standards of urban drainage design, the orders of magnitude of both volumes are similar, demonstrating the appropriate scale of the system for attaining very high hydraulic efficiencies of the demonstrator. On the other hand, to monitor the arising flow volumes in a permeable flooring area like the one described, assuming a run-off coefficient of 0.2 and a ten-minute maximum intensity for the same return period in the range of 200 mm/h, the arising volume flow rate peak would be about 33 l/s. On the other hand, for this type of infrastructure, the design guides recommend that the evacuating drains have a capacity of about 5 l/s/ha, that is 1.5 l/s in the case at issue. Both volume flow rate values are in the range measurable with the instruments it is intended to install in the demonstrator.

9. State of the art and innovative nature of the project

From the mid-1950s, city total surface area has increased in the EU by 78%, while population growth has only been 33% (AEMA, 2006). These data require refocusing the treatment of the ground in cities owing to the enormous environmental impact resulting from the sealing of urban surfaces, increasing the consequences of climate change.

One of the measures for reducing soil sealing consists of using filtering flooring to minimise the impact of urban development with regard to the quantity and quality of the run-off (at source, during transport, and at its destination), as well as of maximising landscape integration and the social and environmental value of the action (ecosystem services). The general principle of these floorings is to collect and pre-treat the run-off and, if run-off quality and soil characteristics allow, to infiltrate the run-off water into the lower layers of the soil. This all reduces the run-off and the relating pollutant loads, such as the hydrocarbons or heavy metals commonly found on roads and parking lots, which can seriously affect the final receiving facilities if such pollutants are not sufficiently biodegraded or retained in the filtration process.

The most widely used materials in these types of surfaces are lawn, gravel, plastic or concrete gratings integrated into the lawn, porous concrete paving, and porous asphalt. LIFE CERSUDS proposes an innovative permeable ceramic flooring, which originated in the frame of an R&D project funded by the Regional Government of the Valencia Region in 2010 "Reuse and recycling of obsolete products or manufacturing rejects for the generation of new products". Ref. IMIDIC/2010/73.

One of the project results was a permeable urban flooring made up of in-stock ceramic tiles of low commercial value that allowed improved management of these products. These ceramic tiles were cut into strips of different width and then bundled into groups of 5 to 8 pieces, forming ceramic modules (Figure 6), which enabled fast and easy flooring installation.

To assure the feasibility of the developed product, mechanical strength and permeability tests were conducted. Regarding mechanical strength, breaking load tests were performed according to standard UNE-EN ISO 10545-4, yielding the values listed in following table.

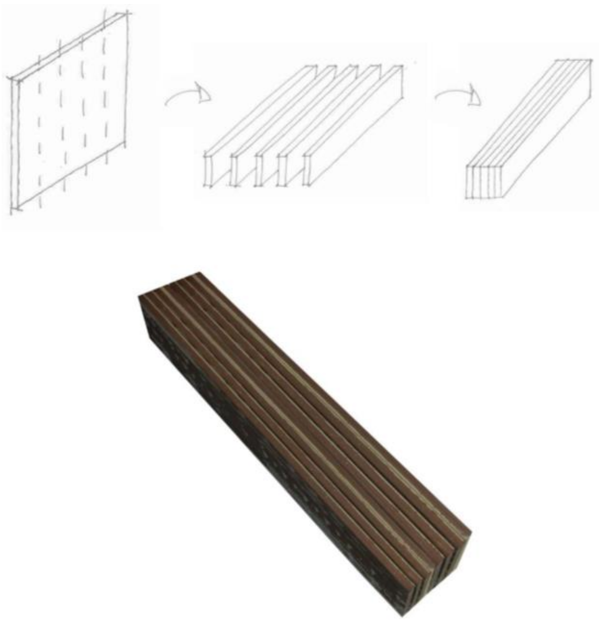

Figure 6. Configuration of the permeable ceramic flooring

These values assured appropriate functioning under the stresses generated by light traffic or small delivery vans so that system durability was estimated to be similar to that of other permeable flooring.

In the permeability tests performed according to standard NLT-327/00, a Coeff. of K 53.2 x 10^{-2} cm/s was reached. The R&D project results were disseminated during the CEVISAMA 2011 trade fair (Figure 7) and the international QUALICER 2012 congress on ceramics.

Assumed values with a coefficient of grounding = 2					
Piece length (mm)	**Strip height (mm)**	**No. of pieces**	**Width (mm)**	**Experimental breaking load (N)**	**Assumed breaking load (N)**
410	30	15	135	2669	5339
410	40	15	135	5596	11191
410	80	15	135	25738	51475

Tabla 1. Valores teóricos de cargas de rotura

Figure 7. Previous project. Cevisama 2010

There are two European projects clearly related to SUDS:

- E^2STORMED (Interreg-MED Programme), "Improvement of energy efficiency in the water cycle by the use of innovate storm water management in smart Mediterranean cities", aimed at developing support tools that allow the introduction of energy saving in the urban water cycle into the decision-making process, with the use of non-traditional rainwater management systems such as Sustainable Drainage Systems (SuDS).
- AQUAVAL(Life Programme), "Sustainable Urban Water Management Plans, promoting SUDS and considering Climate Change, in the Province of Valencia", aimed mainly at providing innovative solutions to problems relating to the quantity and quality of urban run-offs, integrating part of the water infrastructure into the landscape and morphology of the municipalities with the use of Sustainable Urban Drainage Systems (SUDS), thus decreasing the environmental impacts of urban development and contributing social and environmental values to the programmed actions. Several pilot solutions were developed in this project, including a permeable porous concrete paving in Benaguasil (Valencia) thanks to which the feasibility of this type of solution in Mediterranean climates could be demonstrated.

The LIFE CERSUDS project has as starting points the experience obtained in both projects and, in addition, the Regional Work Group monitoring committee created in the E^2STORMED project will be set forth in which key stakeholders in water management in urban settings take part, such as local, regional, and state administrations; water management companies in urban settings; and users.

10. Contribution to EU high-priority areas and policies

The project objective is the adaptation to climate change in areas increasingly subject to heavy rainfall and periods of drought, such as south European regions.

The European strategy for adaptation to climate change contains important lines associated with adapting infrastructures (Commission document SWD (2013) 137 final – Adapting infrastructure to climate change) in which the vulnerability of urban infrastructures to changing patterns of rainfall are explicitly stated. On the other hand, the EU communication "An EU Strategy on Adaptation to climate change" (COM(2013) 216 final) clearly promotes the transition towards a green infrastructure and approaches based on ecosystem services in an urban context: development of local adaptation strategies such as those linked to the Mayors Adapt initiative, development of innovative solutions in managing the entire water cycle in urban settings, promoting and developing green infrastructure in the city, paying special attention to the battle against the heat island effect and to the control of risks relating to urban run-offs, e.g. through permeable surfaces.

The contribution to high-priority policies may be summed up as follows:

- "Climate Change Adaptation": it is sought to accelerate and promote greater resilience in urban areas to CC by a new approach to run-off management. LIFE CERSUDS will implement a demonstrator that improves water management by recovering the rainwater, decreasing soil sealing, and mitigating the effects of torrential rains, and therefore helps palliate the effects of floods and droughts.

One of the European priorities for 2015 is the adaptation of urban zones to CC by using green infrastructures.

The proposed systems (SUDs) are identified by the EU (SWD(2013) 155 final) as a green infrastructure that enhances water management by increasing water retention capabilities, avoiding soil sealing and decreasing the risks of flooding (EEA Technical report nº 15/2011 - Green infrastructure and territorial cohesion. The concept of green infrastructure and its integration into policies using monitoring Systems).

- Priority "Environment and Efficiency in the use of Resources". This project also has synergies with European environmental policies, in particular with the European Directive on flood management (2007/60/EC Assessment and Management of flood risks) and the Directive on water (2000/60/EC Water Framework Directive). The use of SUDs is proposed as a protection measure for surface water management, so that it is framed within the thematic priority of the LIFE programme regarding water, including the marine environment (Annex III, section A, letter a) points i)–ii) of LIFE Regulation nº 1293/2013.

11. Timeline

The project kick-off meeting was held on 13 and 14 October 2016. The project is scheduled to end in September 2019, although the dissemination and monitoring actions will continue beyond that date.

12. Budget

Total amount:	1,817,972 €
59.98% EC funding:	986,947 €