The R.I.E. procedure as a tool for sustainable development in municipality of Bolzano (Italy)

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Abstract: Human progress implies in its conception a progressively more invasive intervention in the sphere of nature. Without an endeavour to conciliate progress with the idea of sustainable development, a substantial number of areas, above all the ones recognized as problematic, would be subjected to an important ecological damage. Legal regulations represent the most binding and cogent instrument to relate the idea of sustainable development to man's will of progress, mirroring the involvement of local authorities in improving the quality of life. The aim of the article is to present positive practices of the application of the R.I.E. procedure (It. *Riduzione dell'Impatto Edilizio*, En. *Reduction of Construction Impact*). The implementation of the R.I.E. procedure allows for appropriate solutions to help maintain the highest level of ground permeability. This aspect of new investments' planning is of fundamental importance, i.e., in areas struggling with the problem of floods or overflows. The present publication adopts the case study method in order to demonstrate the applicability and the positive consequences of the implementation of the R.I.E. procedure as an obligatory tool of the local law practiced since the year 2004 in the Italian municipality of Bolzano.

Introduction

Man's intervention in the natural sphere of life ought to take into consideration the endeavour to maintain a sustainable development, especially in the areas recognized as problematic. The effectiveness of these actions is largely determined by legal regulations, of which the implementation and consistent adherence attest to the involvement of local authorities in improving the quality of life. The aim of the article is to present positive practices of the application of the R.I.E. procedure (It. *Riduzione dell'Impatto Edilizio*, En. *Reduction of Construction Impact*). The implementation of such procedure allows for appropriate solutions to help maintain the highest level of ground permeability. This aspect of the new investments' planning is of fundamental importance, i.e., in areas struggling with the problem of floods or overflows, in fact as marked by K. Rosiek: "atmospheric precipitations are an essential part of water circulation in nature. However, as a result of the unsustainable development process of urban and rural areas precipitations started to be perceived as a source of dangers or a factor which intensifies them."

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The present publication adopts the case study method in order to demonstrate the applicability and the positive consequences of the implementation of the R.I.E. procedure as an obligatory tool of the local law practiced since the year 2004 in the Italian municipality of Bolzano. The article also includes recommendations for the use of similar solutions in Poland. In the theoretical part of the work the concept of sustainable development is represented, as well as the attempt to determine the role that local authorities play in fostering this concept.

1 The concept of sustainable development and the management of rainwater in the municipality

The idea of sustainable development – proclaimed in many international documents and adopted by many states – became a turning point in the global economy. It presupposes an idea of stable development, taking into account the processes of change in which the exploitation of resources, the main investment divisions, the direction of technical progress and the institutional changes remain in a non-controversial and harmonious relationship. In addition to that, thanks to the possibilities to meet the needs of the present, human needs and aspirations will be assured in the future [1]. It is widely accepted that sustainable development is based on three pillars (spheres): economic, social and ecological. It can also be said that it is a socio-economic development strategy, where social cohesion, economic development and environmental protection ought to be taken into account [2]. Such strategy is aimed at continuously balancing these spheres in order to enhance the quality of life and shape development processes, although the ecological aspect of the concept nevertheless appears to be the strongest [3]. On the other hand, as L. Mierzejewska [4] points out, the analysis of the conditions and balance between these spheres indicates the need to consider specifically the spatial aspect, insofar as space is the natural component which determines the socio-economic development in both quantitative and qualitative terms.

In this respect, sustainable development must be linked primarily to the notion of spatial order. The territorial (spatial) dimension of this development has already been exhibited in *Agenda 21* highlighting the role of endogenous resources and grassroots mechanisms of development in this process [5]. The importance of the institutional dimension for the implementation of the concept of sustainable development is also marked in literature by referring to the principle contained in the *Rio Declaration on Environment and Development* [5,6]. This is primarily about adjusting legal norms by restricting the use of resources and values of the natural environment and adding legal and financial responsibility for the pollution or the destruction of nature. Of particular importance is the concept of sustainable development in urban areas, where the result of human activity and intervention in nature is most prominent and, at the same time, the most strongly perceived in the quality of life of man himself. The bodies responsible for shaping the spatial order and for the pursuit of protecting nature are local authorities [7,8], in accordance with the *Municipal Government Act of 8 March 1990*. Their awareness and commitment depends on how much the ideas of sustainable development will be included in the administrative process of the territorial unit. And as indicated by E. Suchanek and M. Mrowiec [9] "The basis for shaping the concept of sustainable development in the urban environment is rainwater retention at the place where the precipitations occurred. This is the proper management of rainwater."

One can find in the literature the indication of the numerous functions of water based on the concept of ecosystem services, where such features are specified: provision, regulation, habitat and culture. In the context of this study, the first two play the most important role. Water is the source which determines the survival of ecosystems and serves as a regulator of the microclimate by means of its ability to purify the air and the surface from pollutants, thereby improving the living conditions of the inhabitants. Moreover, it contributes to

lowering the air temperature of the city. The regulatory function of water understood as an antidote to the increasingly occurring floods and droughts deserves particular attention, because the water infiltrated in the ground reduces the surface runoff and feeds the groundwater to improve its quality (percolation) [10]. Spatial planning is fundamental for the preservation of the spatial order. It is so important that every new project involving the development of the urban area affects the natural sphere of the city.

According to R. Chormański and others [11], problems with the management of rainwater include not only the additional costs for erroneous choices, but also other inconveniences (which are more important from the point of view of development). Recalling the insights in Geiger and H. Dreiseitl [12] and A Peters [13] they stated that "one of the most important impacts of urbanization is the increase of impermeable surfaces (such as: parking lots, paved roads (asphalt, concrete, gravel and others) and houses' roof which prevent the rain's infiltration into the soil and cause it to drain rapidly into the sewage system. The growth of sealed surfaces leads to a shortening of the time of the concentration of the flow and to an increase of its culmination and volume of the flood wave in the catchment area, causing an increase in flood risk as well as increased risk of water pollution."

Precipitation in the form of heavy rains can cause long-term inconveniences in the form of local flooding of such city areas like parking lots, walkways, city parks, playgrounds and other areas of public use. The occurrence and duration of the hindrance is probably related to the type of pavement used and the presence of urban greenery. In the context of this issue it ought to be stressed that a number of proposals of change in terms of conferring new urban areas to the territory still do not take into account the important element consisting of determining the degree of interference in nature in the concrete design solution. Perhaps this approach is a consequence of the fact that there has not yet been a sufficiently detailed and effective application tool that could help the decision-making process.

2 Problems in the rainwater management in Poland

The management of rainwater is a very important part of the spatial organization of urban areas. This issue was acknowledged in Polish literature with particular attention in the 90s of the last century, and for its precursor (due to the specificities of the topic) it is possible to adopt the R. Radwan-Dębski [14]. The author's publication from this period represents the method of estimating the urban sealed surface and is based on the analysis of the degree of seal in relation to the adopted runoff coefficient Ψ . The size of the runoff coefficient is drawn on the measurements carried out by R. Rosłoński and J. Wierzbicki, and is understood as the ratio of effective precipitation to the height of total precipitation. R. Radwan-Dębski's studies. In the assumptions such observations were meant to lead to the usage of the obtained results for the examination of general cases of city hydrology, where the most important value was the effective rainfall understood as the part of precipitation which flows from a specific area into the canal system. In order to systematize the issue, the factors determining the amount of effective precipitation are exchanged. It is considered the most important, among them, the degree of impermeability of the area coverage separating the precipitation from the natural infiltration. The other conditions are: surface quality, decrease, precipitation length, air temperature and humidity [14].

Autor was used to calculate the size of the effective precipitation, which was estimated in two ways, as shown below:

- (1) Effective precipitation = The percentage of the seal (estimated) * The average amount of rainfall that occurred on the surface of the area assigned to the respective type of use
- (2) Effective precipitation = Runoff coefficient * The average amount of rainfall occurring on the surface of the area assigned to the respective type of use.

E. Wojciechowska [15], together with her research team, turns back to Radwan-Dębski's study concept in which the authors calculate an estimate of the percentage of the tight sealed surface, taking into account the type of construction involved. Three types of construction were specified for which the sealing values are represented in brackets. They include: farm buildings (10–20%), suburban buildings (35–50%) and urban (75–100%). Such values present only a general idea of the amount of rainwater retained since the surfaces have been identified.

The identification of the categories of paving in urban areas was also undertaken by N. Borowiec and A. Hamerla [16], who by using the example of a fragment of Cracow analysed and compared the methods of assessing the degree of site sealing. In the study a supervised as well as an unsupervised classification was used (orthophoto), and a point cloud classification, obtained as a result of air laser scanning. In his works K. Rosiek [10] emphasizes that until recently, rainwater was seen as a "problem" and its solution in urban areas consisted of creating an effective system for its collection and discharge into the sewer system. In relation to the fact that water could be both a benefit but also a cause of serious threats for cities, it should be recognized as in the above discussed context of the sustainable management of its resources.

The new K. Jadwigielski's research present that the runoff coefficient has a lots of interpretations and methods of its designation. In order to verify the effectiveness of these methods, the most popular ones in Poland and in Europe were compared based on the example of three hydrologically varied areas [17].

However, the management of water in the city is very difficult, especially due to the dynamic progression of urbanization. For this reason, new investments in urban areas should be adapted to precise standards, which will facilitate the infiltration of water into the substrate.

Serious problems of rainwater administration once grappled the Italian municipality of Bolzano, which due to its location in a typical mountain area (an area with an average height of 264 m above the sea level), in the river valley of Isarco, Sarentina, Adige, is constantly exposed to violent rainfall, surface runoff and landslides. For this reason, the municipality of Bolzano took concrete action during the year 2004. The practical solutions for rainwater management applied in this municipality are presented in the next section of the work.

3 Rainwater management in the municipality of Bolzano

Bolzano is administratively located in the northern part of Italy and is the capital of the autonomous province of Trentino Alto-Adige. In recent decades, the municipality has made significant strides towards the administration of rainwater, which has led to the intervention of local authorities to improve the living conditions of their inhabitants. The first efforts date back to the year 2002 and include the signing of a legal act introducing rules governing the management of rainwater and the related permeability of the soil [18]. In this document is also highlighted the role of hanging gardens (It. *verde pensile*) as solutions contributing to alleviating the effects of atmospheric heating and aiding thermal insulation of roofing's.. The increase in the number of buildings covered by hanging gardens also helps to stop the precipitation in the place where it occurred or at a higher rainfall intensity it contributes to slow the surface runoff. The municipality of Bolzano has undertaken research into the identification of problems and the possibilities of mitigation measures and the compensation of the effects of progressive urbanization and problems related to rainwater administration. The solutions developed were to become an obligatory part of the Municipal Building code, and the choice of the universal model was made to facilitate

objective investment decisions in the field of spatial planning. Finally, it was decided that the most appropriate tool would be to define an index indicating the degree of permeability of the substrate according to the type of site coverage. Therefore, a four-step procedure has been established to define the so-called R.I.E. index. The decision to introduce an obligation to carry out this procedure was fostered by the decree of the President of the Italian Republic number 380 on the 6th June 2001 [19]. This document covers the new "singular text of the laws and regulations in the construction sector" (it. *Testo unico delle disposizioni legislative e regolamentari in materia edilizia*). On the other hand, at the level of the European Union, reference was made to the guideline [20], which was to a large extent referencing the content of the Italian state law No 10 of 9 January 1991. On this basis and thanks to the positive result of the Board of Spatial Planning and Environment's vote (it. *Commissione Consiliare Dell'Urbanistica e Dell'Ambiente*), it was decided to modify the existing municipal regulations by repealing the last paragraph (no 19) and introducing a new one (19 bis) entirely devoted to this procedure. It was ascertained that R.I.E. is a numerical indicator verified in the area of the new investment in order to confirm the impact of the latter and the related change of land cover to soil permeability and the supervening vegetation. This procedure has been applied in Bolzano since 2004 and its practice is obligatory for new investments, reconstructions or expansions [21]. In relation to that the municipal council by approving the calculation model committed itself to prepare and make available to applicants (residents, investors) both the application's forms and the user manual, which are available in the municipality's website [22] (in both Italian and German). The procedure itself is an indication of the impact of the building development and the technical devices applied on the possibility of water infiltration in the field under investigation in the context of the emergence of new investment solutions. In general terms, the application of procedure R.I.E. includes the calculation of the baseline (R.I.E. 1) and the project state (R.I.E. 2), which is carried out in several phases, the detailed description of which is presented in the next section of the study.

4 Procedure R.I.E.

The calculation of the R.I.E. indicator size is carried out on a map scaled 1:200 and represents one of the components necessary to obtain of the investment permit. For this reason, the municipality draws the attention of the residents to several important aspects that have a significant impact on the outcome of the calculations, especially for the size of the R.I.E. 2 indicator, where the investor indicates what the project will be and what he would like to implement in the surface changes. Among the most important changes the municipality collocates: (1) The type of used materials finishing in external surfaces exposed to the direct operation of meteorological waters, (2) management and eventual recovery/reuse of rainwater, and (3) executing urban greens or hanging gardens.

In the light of the foregoing, the same procedure shall be carried out according to the successive steps:

1. Determination of the type of pavement in the test area, indicating the measurement of each surface (in square meters). These surfaces were previously divided into two main categories (Nominatore-numerator and denominatore-denominator), which included 15 and 26 kinds of pavement respectively (see Tab. 1a and 1b). The values of runoff coefficient were elaborated based on the literature, in particular from DIN standards, FLL, A.T.V, Fröhling scale and UNI 11235.
2. The first category of pavements (N) includes permeable areas-where the urban green is utilized (it. *trattato a verde*) and the second category of pavement is all impermeable areas (D) that prevent the natural infiltration of water by determining in a significant way the surface's runoff (it. *non trattate a verde*).

Table 1a. Category covering the types of pavement covered by greenery (nominatore).

Lp.	Category of surface	additional considerations	Runoff coefficient Ψ
N1	Gardens, meadows, orchards		0.10
N2	Rivers of natural stream bed		0.10
N3	Ponds and reservoirs with natural bottom		0.10
N4	Wasteland		0.20
N5	Slabs with grassed escape	Percentage of green surface >40%	0.40
		other	1.00
N6	Grass-covered sports pitches with drainage system	Coefficient of system permeability in m/s $10^0 - 10^{-5}$	0.30
		Coefficient of system permeability in m/s $< 10^{-5}$	1.00
N7	Prefabricated pavements made of synthetic materials, filled and arranged on Grigliati garden	Percentage of green surface >40% coefficient of system permeability in m/s $10^0 - 10^{-5}$	0.40
		Percentage of green surface <40% coefficient of system permeability in m/s $10^0 - 10^{-5}$	v.d.a.d.*
		Others. coefficient of system permeability in m/s $< 10^{-5}$	1.00
N8	Green roofs with a slope of 12° and a medium surface $8 \leq s \leq 15$ cm	Three-layer system	0.35
			v.d.a.d.*
		One-layer system	1.00
N9	Green roofs with a slope of 12° and a medium surface $15 \leq s \leq 25$ cm	Three-layer system	0.45
			v.d.a.d.*
		One-layer system	1.00
N10	Green roofs with a slope of 12° and a medium surface $25 \leq s \leq 35$ cm	Three-layer system	0.25
			v.d.a.d.*
		One-layer system	1.00
N11	Green roofs with a slope of 12° and a medium surface $35 \leq s \leq 50$ cm	Three-layer system	0.20
			v.d.a.d.*
		One-layer system	1.00
N12	Green roofs with a slope of 12° and a medium surface ≥ 50 cm	Three-layer system	0.10
			v.d.a.d.*
		One-layer system	1.00
N13	Green roofs with a layer > 50 cm with filtering and draining	Three-layer system, detailed characteristic according to the UNI standard 11235 (2007)	0.30
		Three-layer system, with the characteristics of the surrounding area not respecting the UNI 11235	1.00
		one layer system	
N14	Green roofs with a slope > 12° and a medium layer $8 \leq s \leq 10$ cm	Applications of solutions for overlays with significant slope, according to the standard UNI 11235 (2007)	0.55
		Not following the standard UNI 11235 (2007)	v.d.a.d.*
	Green roofs with a slope > 12° and medium layer < 8cm	All other solutions	1.00
N15	Green roofs with a slope > 12° and medium layer $8 \leq s \leq 10$ cm	Applications of solutions for overlays with significant slope	0.50
	Green roofs with a slope > 12° and medium layer > 15 cm		v.d.a.d.*

*v.d.a.d – value determined analytically, documented

Source: own elaboration based on the tabular annex of the R.I.E. application available on the website: http://www.comune.bolzano.it/urb_context02.jsp?ID_LINK=512&id_context=4663&page=11

Table 1b. Category covering the types of pavements covered by greenery (nominatore).

Lp.	Category of surface	Additional considerations	Runoff coefficient Ψ
D1	Roofing with metal tiles and slope $> 3^\circ$		0.95
		When surfaces are an integral part of the rainwater reuse system (RRS)	v.d.a.d.*
D2	Roofing with metal tiles and slope $< 3^\circ$		0.90
		When surfaces are an integral part of the RRS	v.d.a.d.*
D3	Roofing of gravel slabs		0.75
		When surfaces are an integral part of the RRS	v.d.a.d.*
D4	Full coverage		0.80
		When surfaces are an integral part of the RRS	avd.a.d.*
D5	Full coverage (terraces) with slope $> 3^\circ$		0.90
		When surfaces are an integral part of the RRS	v.d.a.d.*
D6	Full coverage (terraces) with slope $< 3^\circ$		0.85
		When surfaces are an integral part of the RRS	v.d.a.d.*
D7	Intermittent roofing (tile, shingle, eternit)		0.90
		When surfaces are an integral part of the RRS	v.d.a.d.*
D8	Asphalt pavement		0.90
		When surfaces are an integral part of the RRS	v.d.a.d.*
D9	no data, no item in app		
D10	Pavements from sand-permeable elements	Pavements included in classes A1-A3, acc. to art.11 Specification and Manual of the Engineer	0.50
		Pavements included in classes A4-A8, acc. to art.11 Specification and Manual of the Engineer	1.00
D11	Vertical cobbled pavements	Pavements included in classes A1-A3, acc. to art.11 Specification and Manual of the Engineer	0.70
		Pavements included in classes A4-A8, acc. to art.11 Specification and Manual of the Engineer	1.00
D12	Cobbled pavements, stones, layers with sealed connectors		0.80
D13	Cobbled pavements, stones, layers with non-sealed connectors	Pavements included in classes A1-A3, acc. to art.11 Specification and Manual of the Engineer	0.70
		Pavements included in classes A4-A8, acc. to art.11 Specification and Manual of the Engineer	1.00
D14	Large-cut cobbled pavements with sealed connectors	Pavements included in classes A1-A3, acc. to art.11 Specification and Manual of the Engineer	0.70
		Pavements included in classes A4-A8, acc. to art.11 Specification and Manual of the Engineer	1.00
D15	Sand gravel pavements	Pavements included in classes A1-A3, acc. to art.11 Specification and Manual of the Engineer	0.40
		Pavements included in classes A4-A8, acc. to art.11 Specification and Manual of the Engineer	1.00
D16	Pavements with macadam, streets, courtyards, squares	Pavements included in classes A1-A3, acc. to art.11 Specification and Manual of the Engineer	0.35
		other types of foundation	v.d.a.d.*
D17	Loose gravel surfaces		0.30
		other types of foundation	v.d.a.d.*
D18	Railway tracks		0.20
D19	Sports facilities on clay with drainage system	Indicator of system permeability in $\text{m/s}10^0 - 10^{-5}$	0.40
		Indicator of system permeability in $\text{m/s} < 10^{-5}$	1.00
D20	Sports facilities with a drainage system and synthetic substrate	Indicator of system permeability in $\text{m/s}10^0 - 10^{-5}$	0.60
		Indicator of system permeability in $\text{m/s} < 10^{-5}$	1.00

Tabel 1b. (cont.) Category covering the types of pavements covered by greenery (nominatore).

D21	Watercourses with impermeable bed		1.00
D22	Tanks, ponds, reservoirs with artificial substrates, impermeable		1.00
		When surfaces are an integral part of the rainwater reuse system	v.d.a.d.*
D23	Reservoirs, joints, basins with permeable substrates		0.10
		Depending on the permeability of the substrate and when the surfaces are an integral part of the rainwater reuse system	v.d.a.d.*
D24	Different types of substrates with CLS, glass and plexiglas		0.95
D25	Ducts, grates, gutters		0.95
		When surfaces are an integral part of the RRS	v.d.a.d.*
D26	Wooden substrate with non-sealed connectors		0.50
		When surfaces are an integral part of the RRS	v.d.a.d.*
v.d.a.d.* - value determined analytically, documented			

Source: own elaboration based on the tabular annex of the R.I.E. application available on the website: http://www.comune.bolzano.it/urb_context02.jsp?ID_LINK=512&id_context=4663&page=11

Among other things, it was noted that asphalt-covered parking lots, but densely covered with trees, could not be considered as green areas but would be part of the impermeable areas. In the event of a difficulty in determining the type of pavement, the inhabitants have the opportunity to take advantage of the assistance of the specialists working in the municipality, and where none of the surface types indicated in the table correspond to that identified on the ground, the investor has the opportunity to designate it as a distinct one, which must be substantiated by appropriate documentation. Such operation also involves assigning a specific value to the runoff coefficient Ψ . This identification of all surfaces is performed for both the initial state and the target state.

1. The conduction of a qualitative analysis, categorization and calculation of the number of trees in the surveyed area. The qualitative analysis is understood here as determining whether a tree can be assigned to a corresponding height category. This is conditioned by the place of planting, which can limit the full height (lack of sufficient light, the necessity of cutting the branch or apex). The categorization includes assigning each tree to one of three separate height compartments: (1) the first category with a height of over 18 meters, (2) the second category with a height between 12 to 18 meters and (3) the third category where the height of the tree is limited to a range between 4 and 12 meters. Trees are counted for both the initial state and the target state, if more plantings are provided.
2. Entering data into the application. The R.I.E. indicator value in this application is calculated according to the following formula:

$$R.I.E. = \frac{\sum_{i=1}^n Svi \frac{1}{\psi_i} + (Se)}{\sum_{i=1}^n Svi + \sum_{j=1}^m Sij \psi_j} \quad (1)$$

RIE = Index of reduction of construction impact;

Svi = i-th permeable surface, impervious or sealed areas where the urban green is utilised;

Sij = j-th permeable surface, impervious or sealed areas where the urban green is not utilised;

ψ_i = i-th runoff coefficient;

ψ_j = j-th runoff coefficient;

Se = Surfaces corresponding to trees.

Due to the need for a detailed and comprehensive description of the data entry into the application, this issue will be deliberately omitted.

3. After entering the data into the application, the values R. I. E 1 and R.I.E. 2 are obtained.

The R.I.E. coefficient is used in the areas of the municipality of Bolzano, where the Local Spatial Planning Plans apply (it. *Piano Urbanistico Comunale, P.U.C.*). The municipality accepts projects where the index values are in the range between 1.5 and 12, where the first value indicates the lowest amount that will allow the project to be executed. This value is tolerated only in areas intended for industries. For residential areas the lowest acceptable indicator value is defined at level 4. These values have been established provided that each actual size calculated is lower than that which will be shown after the project is implemented. This means that each new investment aims to increase the value of the indicator, even if in the first stage of the calculation it already had a satisfactory result.

5 Summary

Nowadays water management is scrutinized through the prism of benefits and risks as one of the elements for the implementation of the concept of sustainable development in urban areas. It is also a matter of interest for researchers. This work presents the three main approaches towards the administration of rainfall, by R. Radwan-Dębski, N. Borowiec and A. Hamerla, and the one used by the municipality of Bolzano. A tabular comparing these three attempts is presented below (Tab. 2).

The introduction by the Italian municipality of Bolzano of the obligation to carry out the R.I.E. procedure is an example of the application of good spatial planning practices. The municipalities, through these specific actions, present their state of environmental awareness and influence its increment among residents and investors. The knowledge of the nature of rainwater administration allowed a number of possible solutions, which resulted in the development of a tool for an objective assessment of the impact of construction on the changed rainwater retention. The key element was, however, introducing it into local law as an obligatory procedure conditioning the possibility of realization of new investments. These solutions seem to be a valuable example for an application within the Polish conditions, where in many cities there is a problem of flooding, the frequency of which is probably related to the intensification of construction. The Polish efforts in the area of rainwater management have undergone since the 1st January 2018 a significant change due to the fact that local authorities are obliged to charge for the so-called tax on rain. This is governed by the Water Law Act [23], which will condition water management and reuse. This is a significant step towards the sustainable management of natural resources.

Table. 2. Summary of the selected approaches to the problem of the retention of rainwater.

Comparative criterion	Approach		
	R.Radwan-Dębski	N. Borowiec, A.Hamerla	Bolzano municipality
Pavement	The map is based on 12 types of paving	Based on methods of laser scanning, orthophotos and aerial photos, four classes of land use have been designated (buildings, bituminous roads, unpaved surfaces, green areas)	Split into two categories according to the greenery criterion: (1) 15 types of pavement (1n to 15 N) are specified, where greenery is present, and (2) 25 types of pavement (1d to 26 * D), where greenery is not present
Runoff coefficient	The indicator value was adopted according to R. Rosłoński and J. Wierzbicki's calculations	Not specified	The value of the indicator is assigned for each type of pavement, but it can also be assigned manually for new areas not identified in the table
Trees	Not included in the calculation	Three vegetation height ranges are defined (0-1.0 low, 1.0-3.0 mean and > 3.0 m high), which were used to determine the remaining	Trees are a important part of the calculation three categories of trees were defined according to their height (4-12 m - 3°category, 12-18 m. - 2° category, > 18,0 m - 1° category)
Study method	Use of the conventional percentage seal, taking into account the magnitude of the average precipitation and the runoff coefficient	(1) Unattended and attended raster classification (ORTHOPHOTOMAP)-Micro software DEM 16.0, (2) point cloud classification, TerraSolid LTD software (MDL application)	Adoption of the application crated by the municipality to calculate the R.I.E. indicator
Applied scale	1:5000 i 1:10 000	1:10 000	1:200
Main application aspect	Since such method was originated during the 90s of the XX century, it didn't include an application aspect	Support Tool for instance for sewage network design, sewage treatment, storm overflows, urban wastewater revitalization	The presentation of the results of the procedure is obligatory during the attempt to realize the construction project
Difficulties of the methods	Lack of sufficient measurement accuracy (estimated values), need to complete the calculation - verification in loco	Distortion of calculation (shadow in the Ortophotomaps, identification of buildings with black roofs, an obscuration of the terrain by treetops)	The necessity to make detailed studies in the area, to determine the type of pavement, to manually assign the values of the runoff coefficient and to document the accepted values

Source: own elaboration based on R. Radwan-Dębski [14], N. Borowiec, A. Hamerla [16] and www.bolzano.it [22]

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