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Building in post-war environments

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Abstract

Modern wars generate devastating effects on the environment by using chemical, biological, radioactive weapons. Toxic effects persist for long time on war fields. Negative environmental impacts such as desertification, migrant masses, depletion of natural resources (food, water, wood, etc.), and induced biodiversity produce, in turn, conflicts.
This paper aims at i) identifying the consequences of conflicts and wars on the built environment with special reference to the industrial and residential buildings in urban areas; ii) determining the environmental impact of the procurement and use of natural resources and materials for the reconstruction of human settlements; iii) describing the results of this contribution according to their practical use. The research starts with a critical analysis of international examples related to modern wars. Contemporary situations of environmental degradation also related to major natural disasters that have altered the context in which they happened have been then analysed. Moreover, results of some significant interventions of environmental clean-up and building reconstruction have been examined, together with guidelines of the international humanitarian organizations on aspects of health and quality of life in areas with depleted environment. Results of these studies permit to suggest a post war methodology for the revitalization of the territory with restocking and monitored rebuilding, coordinated with contextual recovery of ecosystems. Construction techniques, with characteristics of resilience, habitability and sustainability are finally proposed. These solutions must also strive for reintegration of personal property and for the definitive localization of residents respecting their traditions and culture.
Overall, this paper gives an operative contribution to one of the most important problems of humanity, which can be useful to future researches on territories marked by the environmental degradation caused by wars. Recovered environments, made sustainable, may help to understand that the real solution is avoiding wars and their deleterious effects.

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1. Introduction

In the past, when a war ended, everyone rejoiced, the peace was restored, life began again: upon reconstruction, pain and discomfort were forgotten. Now it is no longer the case. Modern wars, with their chemical weapons, radioactive bombs and targeted biological destruction, produce environmental devastation both on natural and anthropic systems [1], often creating total uninhabitable situations for a long and unpredictable time.

Apart from their direct consequences, as the destruction of entire ecosystems, conflicts induce desertification, deforestation, water and air pollution, and poisoning of soils that, in turn, may cause the habitat abandonment, the displacement of mass refugees, the cancellation of the local economy, traditions and culture of entire populations.

Already during the Second World War, the study of toxic substances to be used to overthrow ecosystems and cause damage to the enemy gave birth to the industrial production of pesticides that were widely used in agriculture, not always properly. It is from the 60's onwards that the use of toxic substances has developed. Obviously, these substances are not limited to ravage theatres of war, but they affect neighbouring states and territories, that suffer serious environmental and often irreversible damage.

Unfortunately, there are endless quotable examples regarding the employ of deadly weapons for the environment. Below are some of the conflicts that have arisen in the last 50 years for various reasons (religion, economy, territorial domination, ethnic groups, tyranny, only to cite some).

From the Vietnam War (1962 - use of defoliant "Agent Orange") to the Gulf War (1991 with an air pollution that reached India), to the civil war in Syria (2011 and ongoing), up to the present day, there exist about 60 ongoing conflicts in Africa (Central African Republic, Somalia, South Sudan, etc.) [2].

At the moment, in Asia there are conflicts and wars involving about 15 States (Afghanistan since 2001, the Philippines, Pakistan, Myanmar). In Europe, Ukraine and Chechnya are currently involved in wars, while in the Middle East, there are several breeding grounds of conflict, such as the conflictual situation between Palestine and Israel, Iraq (ISIS), Syria (civil war since 2011 - perhaps the most violent ongoing conflict at present), and Yemen [3]. Even in South America there are several examples of clashes with devastating effects on the territories involved. However, beyond the tragic stories of these single events, for the purposes of this paper it should be noted that from the 60's armed conflicts have had an increasing negative effect on the environment [4]. Since then, the weapons employed, dramatically improved and enhanced in their toxic and radioactive effects, have spread out massive pollution in the air and in the water, without stopping at the borders of individual states, and have had severe, persistent, and unforeseeable effects on the health and the environment. Therefore, environmental aspects are absolutely pivotal, although they have been often neglected and considered secondary to the priorities to be faced in war zones.

The environmental protection of these areas for the post-war future is definitely crucial, in the light of the lessons learnt from previous devastating experiences such as the deforestation in Vietnam, the destruction of oil wells in Kuwait and Iraq, and the pollution caused by depleted uranium in the former Yugoslavia [5]. It has been proven how, after many years, all these events still have deleterious effects on the local population. In particular, the Kosovo war in 1999 has produced negative impacts on vast territories: Albania and the former Yugoslav Republic of Macedonia have accommodated a huge number of refugees from Kosovo, with a total unpreparedness to face such an enormous flow of people [6]. Other neighbouring countries, in particular Bulgaria and Romania, in the Danube valley, have suffered the effects of pollution coming from across the border, particularly harmful for industrial sites. The fires in refineries and oil depots have created pollution clouds over large areas, as well as numerous hazardous chemical agents spread in the air, land and water.

In Kosovo, Serbian forces systematically evacuated and destroyed villages and entire cities with obvious damage to housing, infrastructures, and drinking water reserves. When the Kosovo Albanians abandoned their homes and fled, several documents related to private property got lost or were destroyed. This has inevitably created major complications when refugees decided to return to their homes [6].

Other problems related to healthcare, food and water supplies have arisen in the difficult management of overcrowded refugee camps. These situations are very topical in Europe, with reference to the aforementioned ongoing conflicts. The masses of migrants involuntarily create difficulties in people's integration and flows management, but also induce a political unease that has shaken the entire European civil frame and jeopardized its survival as a united country.

Normally, after the destructions caused by war and its consequent pollution effects, large housing reconstruction and social projects are initiated, in conjunction with parallel programs aimed at re-establishing the "resilience" [4] of the area, through mine clearance (in Kosovo it has been done for 20 years now), reforestation, clean-up and every possible action needed to reclaim and recover contaminated environments. Unfortunately, sometimes the degradation is irreversible throughout the territory. Nevertheless, after a disaster, a very attractive business for countries and the business community is triggered [1], in the face of an enormous and inestimable cost made of lost lives, disappeared biodiversity, jeopardized environments, deleted traditions and cultures. In this context, the adoption of a rigorous methodology based on reliable data is to be considered the only way to set up a consistent protocol that can re-establish actual healthy and normal living conditions in the areas devastated by modern weapons. The process of urban reconstruction in reclaimed and restored sites has to provide for initial strategic phases. The final choice of the location has to be based on criteria including logistics, future economic and social growth of the area, and the definition of preliminary interventions in order to equip the site with infrastructural and services networks. The subsequent phases of reconstruction and refurbishment (where possible on buildings and monuments of cultural heritage significance) have to be planned considering principles of resilience and sustainability.

1.1. Aims

As mentioned previously, one of the strategies to win modern wars is to destabilize the enemy by hitting heavily not only military targets, but also major urban tissues. For instance, the bombs on Hiroshima and Nagasaki were crucial, albeit in a tragic way, in defying the end of the Second World War. This trend has been subsequently developed with the technique of guerrilla warfare (Vietnam) [7] and terrorism (Al-Qaeda, ISIS), in which the combatants blend and hide themselves in cities and villages, and make it extremely difficult to select targets that may spare the civilian population [8]. After all, numerous strategic objectives for destruction are closely connected with the urban environment, e.g., airports, ports, industrial plants, political and military installations for command and coordination [7].

The consequences on urban centres are obviously devastating, not only in terms of human casualties and environmental disasters. As a matter of fact, the negative and often irreversible effects on ecosystems persist after the war, hindering the correct use of the affected territory and the impossibility to restore the previous housing and natural conditions in the short term.

In addition to the total or partial loss of the housing stock of any urban centre, the effects of chemical pollution [9], e.g., water, deforestation, residual radioactivity, and military remains, e.g., minefields, unexploded ordnance (UXO), do not allow to use local resources for a feasible reconstruction [10]. Obviously, concrete produced with polluted water, timber flooded of metal splinters, or any materials deriving from radioactive rubbles on radioactive soils cannot be taken into consideration for the rapid recovery of human settlements. These issues intersect with the flow of refugees who leave their habitats and migrate, creating problems of acceptance and accommodation in the neighbouring places and states. Hence, a double problem arises: tackling the reconstruction of buildings and infrastructures in war zones and organizing the transitional building activity for the masses of refugees, who cannot be easily absorbed and integrated in the hosting countries.

In both cases, financial resources, natural and artificial materials need to be sourced, although with a different time meter [11]. While refugees need immediate hospitality and emergency shelters, in post-war areas it is necessary to ensure the recovery of entire ecosystems, the clean-up of vast territories, the restoration of basic living conditions and the collection of financial resources for food, energy, health and social care [12]. In particular, it is essential to gather data and observations for the accurate knowledge of dangerous circumstances, e.g., mapping of radioactive data, topographical identification of minefields and pollution levels in all the water forms within the territory. The main purpose of this paper is to identify a systemic approach to the problem of housing reconstruction in post-war areas, based on a logical sequence of actions and achievements to optimize the intervention time.

2. Environmental devastations due to modern wars

In this section, the critical analyses of some examples of environmental devastation due either to modern wars and conflicts or natural disasters (Chernobyl, 1986, radioactive clouds up to Scandinavia and Finland and impoverishment of the whole Ukraine - Fukushima Nuclear Power Plant Dai-ichi in Japan in 2011, various Tsunami events, etc.) is reported [13]. The aim is to evaluate the effects of the events, to further proceed with the necessary environmental clean-up and subsequent repopulation of damaged territories. It is also appropriate to focus on the effects of radioactivity and the consequences that should be monitored before starting inadequate and/or insufficient recovery actions. In cases where it is required to restore urban territories with the use of materials and the responsibility for the health and safety of the people to be resettled, it is pivotal to be aware of the dangers caused by radioactivity. The following are some considerations deemed useful to frame the relationship between radioactive effects, environment, materials, and reconstruction. Finally, we add some important notes on the guidelines provided by international and humanitarian organizations which deal with all aspects of health and quality of life in degraded environment contexts [14, 15].

2.1. Depleted uranium

Enriched uranium is produced from Natural uranium, essential for nuclear power generation and nuclear weapons. Since 1940 the enriched uranium demand has increased particularly for military applications based on the use of depleted uranium . One of three major radioactive isotopes of natural uranium, U - 235, is the fundamental component of enriched uranium, with 1 kilo of U - 235 producing about 200 kilos of depleted uranium [16]. The wide availability of this material, that needs special disposal and storage protocols, has encouraged research and applications in the military sectors (aviation, artillery, rocketry), including the use of plates for the protection of tanks, that cannot be attacked by bullets and by conventional bombs. However, the 1991 Gulf War has shown that these protection plates are penetrated by uranium-based munitions, exposing both the local populations and fighters to the risk of radiation and absorption by inhalation. Depleted uranium drops off as a heavy metal on the territory and reacts with the water vapour in the atmosphere forming toxic uranyl fluoride, in addition to a highly corrosive acid in the form of aerosols [17]. This affects basically every form of life: natural environment (water, air, and soil), fauna, flora, and human race. In particular, some American medical studies have illustrated the chemical and radiological risks associated with the indirect intake of depleted uranium in the human body, both causing alterations and various types of cancer, especially in bones, kidneys and liver. Nuclear radiation on non-living materials produce effects primarily due to the ionization and consequent breaking of chemical bonds and the transmutation of some nuclei in other elements. These effects change the environment and can become very dangerous for living beings. Some negative effects are also found in construction materials and elements, including finished building components: the transmutation makes it relevant to accurately choose the steel and other metal alloys used in radioactive environments, because the radioactive accumulation changes their chemical and physical composition and can lead to the loss of mechanical resistance, stability and durability, either chemical or physical.

Concrete is also affected by the same drawbacks, although in a less accentuated way. It is understood that reinforced concrete significantly deteriorates due to the steel reinforcement [18].

Radioactivity can also make an electronic circuit based on semiconductors unusable, by transmuting the silicon atoms and altering the electronic components of which they are made of. The hypothesis of shields to protect both transitional shelters and reconstruction housing from the residual radiations in a post-war territory is difficult to apply, due to the different materials employed in a building structure, albeit simplified, and adequately protected.

Generally, the more mass is interposed, the better the anti-radiation effect: a lead lining, extremely dense, has an excellent absorption capacity towards radioactive particles and has the advantage of being very stable, opposing the transmutation into other dangerous elements. While alpha rays and beta emissions arising from the ionization can be successfully stopped by interposing a shielding of any solid material with a few millimetres thickness or a 10 cm thick air chamber, an effective shield against the X-ray photons and gamma constituents must be thicker, and made of a very dense material, such as steel or lead. It is even more difficult to shield a neutron radiation, since these particles are deeply penetrating: neutrons, depending on their energy and on the material, can react with nuclei in different ways. Hence, an effective screen is obtained through multilayer shields with heavy materials (such as iron)

in the inner part and light materials in the outer part. Since the materials employed in emergency shelters (wood, plastics, fabrics, etc.) cannot respect the heaviness and density principle, due to the fast shipping and quick assembly required, they are not easily protectable from the residual radioactivity in war theatres. As a consequence, it becomes pivotal to be fully aware of the radioactivity values and their map localization and concentration, in order to make an informed prediction about the localization of new settlements.

3. Role of international organizations

For the purpose of this paper, it is also appropriate to recall the guidelines and policy of the various international organizations and NGOs that deal with environmental issues in post-war contexts. We can first note that their creation or merger with other existing organizations occurred as a direct result of specific events. In general, poor coordination, also due to difficult relations with the local authorities in the territories marked by war, can be noted as a common aspect. The role of international organizations is to publish guidelines and non-prescribing suggestions, but sometimes these lack of ongoing monitoring and subsequent update.

A significant example in this area is represented by the work of UNEP (United Nations Environment Programme). Born in 1972, it joined UNCHS (United Nation Centre for Human Settlements) to deal with post - war problems in Kosovo [6] and set the first guidelines on post-conflict environmental issues in Afghanistan in 2002 [19]. In that year, the Grand Council of Afghanistan, after 30 years of territorial devastation, migration and health problems, finally decided to prioritize the management of the environmental crisis in the new government.

The result was UNEP's Post Conflict and Disaster Management Branch, created to assess the situation and publish a report with their findings, in agreement with the Transitional Government of Afghanistan. However, to date the pollution caused by the obsolete sewage and aqueduct has apparently worsened and the demining activities are still ongoing, as well as in Kosovo [20]. However, since 1999 UNEP / UNCHS has been the first real organ of "post-conflict environmental assessment" in the world. Another organization that is worth mentioning is the UNSCEAR (United Nations Scientific Committee on the Effects of Atomic Radiation). Established in 1955 after Hiroshima and Nagasaki, UNSCEAR deals with radioactive leaks due to non-war events, such as Chernobyl in 1986, it collects data from governments and various organizations and publishes reports and recommendations on health and reconstruction.

There are many other organized bodies that sometimes undergo the lack of support from military sources and in any case cannot (and should not) override the local governments, already harassed by numerous post-conflict issues, such as heavy economic crises which hinder any program of re-establishment of the normal living conditions.
Before finalizing a methodological approach aimed at the final restoration of the habitat and all its activities (anthropogenic, manufacturing, construction, etc.), here are some hints on the tools that are deemed useful in the emergency housing phases before the final reconstruction.

4. Emergency construction techniques and products

In this paragraph, several construction typologies are shown. These have been selected considering the two main needs associated with war sites: a) emergency dwelling, and b) medium-long term building solutions needed to host people during the preliminary post-war interventions of mine removal, depollution, and radiation abatement. In both cases temporary dwellings have to be characterized by easiness of maintenance and deconstruction, whilst guaranteeing suitable comfort levels.

Several architecture firms from different countries and various organizations have developed residential units of different functionality and quality. Below are reported some examples (not to be considered exhaustive), featured for the different materials employed and the innovative assembly procedures, already tested on a variety of modern post-war sites [21].

4.1. Self-build

This construction technique, basically dry and adaptable to any context, applied without the use of heavy duty vehicles and skilled labour, is recommended (and has widespread) both in case of temporary housing after natural catastrophic events and in post-war emergency housing [13]. Besides self-build individual cases, several research works, patents, and experiments have been developed to provide standardized products with mounting kits and recommendations which also contain the successive phases of demolition, deconstruction with recycling or waste disposal.

Basically, the main features of self-built housing are as follows:

- Dimensional and technological flexibility
- Adaptability to local and climatic contexts
- Suitability to integration

It is noted that this technique meets the environmental compatibility goal, which also takes account of traditions and local culture [22].

4.1. Textile wall

The flexible panel called "Textile Wall" was patented in 2015 by the Politecnico di Milano (Italy), under the European project Speedkits, within the Seventh Framework Programme, and aimed to build housing rapidly in emergency conditions [23]. The patent is very valuable as it is possible to use local materials, not contaminated and easy enough to source, for the completion of mini temporary housing units. The panel is made up of cells composed of thin plates of semi-rigid material which are filled with structural materials, derived from local technologies, and closed by textile membranes. By using this panel, it is possible to create external vertical walls, as well as internal partitions and roofs of various sizes and forms. The traditional construction techniques complement this innovative proposal, which has been presented as an easily displaceable flexible shuttering, thanks to the possibility to pack the folding structure in an easy-assembly kit.

Fig. 1. Textile Wall (source http://universitime.corriere.it).

4.2. Cardboard house

The Japanese architect Shigeru Ban has proposed a solution for emergency housing after natural disasters or war conflicts, with the use of poor technologies and waste materials, extremely cheap and easy to transport and assembly. In particular, he employs suitably waterproofed cardboard tubes, to shape the walls. In the case of the Kobe earthquake in Japan, these structures were used to build temporary housing, with foundations made of beer crates filled with sand. As a result, the cardboard houses in Kobe were used for a long period after the earthquake.

The first version of this project was adopted after the war in Rwanda in 1994 and involved the use of wooden elements. However, since the end of the war had produced a heavy deforestation, the architecture firm elaborated new solutions which first involved aluminium tubes to create all the partitions and finishes, and then employed waterproof cardboard tubes as the definitive construction material [24].

The combination of simple structural elements of metal or wooden carpentry allows the rapid construction of fairly resistant shelters, with the extraordinary conditions of use. Another relevant feature is the ease of replacement of cardboard tubes, hence the shelters have a remarkable resistance even in difficult weather situations, combined with a high value in terms of sustainability.

4.3. Pallet house

The "Pallet House", built in the late 90's by Studio I - Beam from New York, was designed to provide temporary accommodation to the refugees returning to Kosovo, as an alternative to the first aid tent cities, and then spread across the world (Iraq, Afghanistan, Darfur, Ethiopia, and Syria) [25]. The recycling of pallets allows, with the aid of a mounting kit, to self-build a small house in one single day. The architecture firm has estimated that solely with the American yearly production of pallets, the needs of temporary housing for 40,000 refugees would be covered (the estimated average usage of shelters by refugees is 7 years). Moreover, transportation costs on the place of exploitation areas are very low, because pallets are the most common means to ship food, medicines, various equipment dispatched to the refugees. Pallets are so cheap, readily available, affordable, very versatile, and can be combined with local materials such as earth, wood, etc. to complete the walls, and with corrugated sheets and locally produced tiles to build the roofs. This type of intervention can easily be turned into a stable building with the addition of local materials for the structures (concrete, stone), the finishes (plastic, rubber, mud, plaster) and with use of thermal insulation materials, vapour barriers and other components for the building plant design. The "Pallet House" has been awarded multiple times, with some prototypes being built over time and exhibited in various international exhibitions including the Venice Biennale, Italy, in 2000.

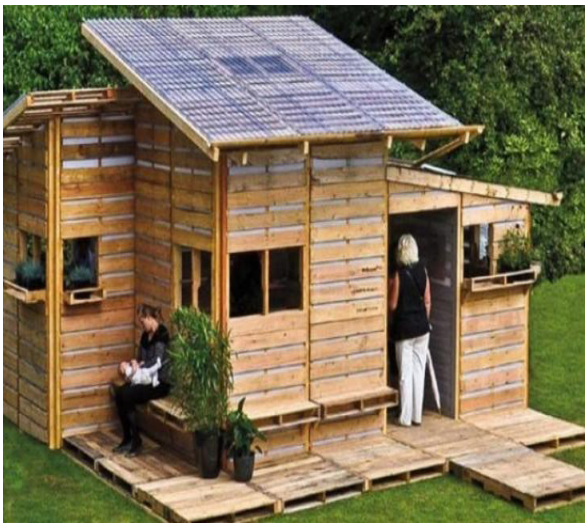

Fig. 2. Pallet house (source http://www.viralnova.com/build-a-pallet-house/) .

An example of aggregation of Pallet House housing units allows to appreciate how versatile and environmental friendly this US patent is, with its PV panels applied on swivelling pitched roofs - definitely the most convenient way to capture the sun rays - which allow self-production of energy.

4.4. Container homes

The idea of using containers as temporary housing dates back to the 50's, but research in this field has never been abandoned [26]. This solution, easily transportable and mountable in a very short time, even on different levels and configurations, has been developed in particular in the Netherlands. In Europe, container homes are considered not only for emergency shelters but also for a low-cost housing to be implemented in urban areas, for their high ecological and environmental value (social housing, cohousing). The shape is such that it can be an easy support for residual radioactivity shielding. Furthermore, it can be ideally combined with simple completion technologies (foundations, plants), which can be conveniently found on site in the case of post-conflict territories.

Fig 3. Container home (source http://dornob.com/shipping-container-homes-modern-simple-sleek-design/) .

It is understood that the examples reported in this paper are just some of the numerous international patents and proposals, but they have been considered significant to demonstrate the relevance of the choice of materials in each context. In general, it can be noted how the houses made of wooden elements are able to provide housing solutions that meet any requirements in a relatively short time, compared to the units made of different materials, which also require more an expensive transportation [27]. The preconditions for the solutions built with wooden structures can be summarized as follows [28]:

- Prevalent use of energy-efficient and non-toxic materials
- Formal and dimensional flexibility
- High energy efficiency
- Remarkable durability, minimization and ease of maintenance
- Recoverability and recyclability of the materials after removal or demolition

5. Reconstruction

When limited to the construction industry, and in normal civil conditions, the term “reconstruction” refers to the interventions, regulated by the applicable law, which occur in any built environment. On the contrary, when addressed to post-war scenarios, reconstruction has to be intended as a comprehensive medium and long-term view of environmental, health, economic issues, arisen in war sites [2]. It also involves data collection, analyses, and mapping, aimed to gather a perfect understanding and awareness of the impact of the recovery operations of natural habitats. This phase should be preparatory to re-designing the urban, industrial and infrastructural systems.

In this context, a twofold issue arises. On the one hand, the accountability and solidarity towards the people who wish to resettle in their environment, on the other hand the concern in assessing the critical values of various types

of pollution. An example is the assessment of residual radioactivity. It is clear how necessary it is to monitor values, the diffusion and localization of residual radioactivity. Unfortunately, it is not unlikely that, according to the "military secret", the mappings are created but not made available to operators, who could initiate the reconstruction works in territories where the risk had been previously assessed. Modern conflicts, therefore, leave effects that cannot be cleared in a short time. In Vietnam, as in Kosovo and in other theatres of war, after more than 20 years from the end of the conflicts, the living conditions of the returned refugees are still precarious, not adequately assisted, especially with reference to healthcare [29].

The post-war path, therefore, is much longer than expected. It is necessary to define a well-organized program based on the knowledge of the actual state and the responsiveness to possible treatments to revitalize the area. Obviously, the contextual situations are numerous and varied, as for the entity of the destructions and the quality of what has been spared from destructions. Hence, it is also necessary to set up a specific approach to the urban fabric to be restored, which should go beyond the traditional iconographic and cartographic sources that were probably destroyed during the wars and destructions. This approach involves new sources of analysis-based knowledge, to be integrated with what is still detectable and recognizable in the territories in which to operate. This approach should include infrastructures and urban facilities to be optimized, typological and morphological analyses of cities to be recovered (drawing of lots or block, street network, monumental and/or religious references, etc.), and also analyses concerning the mobility, crafts and trade areas, property subdivisions, anthropological and socio - cultural issues, and requirements analyses. The knowledge base defined above is indispensable to complete an overview that can guide an appropriate and correct reconstruction. Once these preliminary steps have been completed, it is possible to initiate the building reconstruction, which involves both practical (the collection of resources and material) and cultural issues - reconstruction according to the local traditions, or globalization-based building, such as in China, or Japan after World War II?

Under the term “reconstruction”, the term "refurbishment", limited to architectural works (monuments, theatres, etc.), can also be included [30]. However, once the bond of the building shape has been tackled, reconstruction can also open up to the art world. An appropriate example of a modified building shape is Dancing House designed by Frank Gehry and built in Prague between 1992 and 1996, which well represents the entrance of modern architecture in the traditional urban fabric [30]. All things considered, the methodology for a valid reconstruction path can thus be outlined as follows:

- Accurate knowledge with mapping, data collection, critical analysis and monitoring of the environmental issues of the territories on which to intervene, with an emphasis on radioactivity (depleted uranium)
- Programming in different time frames (short, medium and long-term), for clean-up actions and physical and environmental rehabilitation of the territory, with particular reference to:
  - Air, water, soil, agricultural production, social- and healthcare
- Allocation of temporary accommodation for returnees or residents who have lost their homes. All-inclusive supply of goods and/or assisted self-construction.
- Specific care in soil remediation, with mine clearance and dismantling of other unexploded items
- detailed plan for waste disposal (especially for toxic waste, including medical waste)
- parallel administrative program with:
  - reconstitution of technical and financial offices with local administrative personnel (if possible) or interim staff;
  - regularization of property rights by setting up procedures and essential operations;
  - Organization of a cadastral information system
- urban planning and regulation of settlements, social and technological infrastructures, to be built with particular attention to the traditions and the local culture- not to be wasted in commercial operations within a mere backdrop of anonymous globalization.
- Assessment of the clean-up framework and residual radioactive emissions before the final building reconstruction
- Mapping of the possible reconstructions and demolitions with benefit threshold
- Reconstruction and final rehabilitation of the territory, according to the reachable degree of resilience.

6. Conclusions

This paper aimed at raising interest on one of the current great problems of humanity and inspire future research both on the environment, construction and "informed and educated" anthropization, in the territories marked by environmental degradation and the destructions caused by war. The example of the war in Kosovo, included in the introduction, reminds how – even after 20 years from the end of the war – neither the preliminary activity of mine removal, nor the rehabilitation of a liveable environment have been completed. This shows the impact of modern weapons on the environment and on construction materials (both natural and artificial). The role of international organizations is essential in defining strategies for the rehabilitation of war sites and for the construction of emergency shelters for refugee population, in view of the definitive restoration of the sites.

A final conclusion that may seem obvious, but which is faced with economic, political, religious, ethnic -and anything else the man has invented to provoke conflicts and wars- is that the real solution is to completely avoid wars and the deleterious effects resulting therefrom.

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