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Humanitarian Demining and Sustainable Land Management in Post-Conflict Settings in Sri Lanka: Literature Review

Harshi Gunawardana[1], Dammika A. Tantrigoda[1] & U. Anura Kumara[1]

[1] University of Sri Jayewardenepura, Colombo, Sri Lanka

Correspondence: Harshi Gunawardana, University of Sri Jayewardenepura, Colombo, Sri Lanka. Tel: 94-77-407-6474. E-mail: phd6115fm2014019@sjp.ac.lk

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Abstract

Systematic humanitarian demining carried out with care is an essential prerequisite for sustainable land management in post conflict settings. Degradation of land and pollution of water, soil and vegetation, as well as poisonous gas emissions that may even contribute to climate change, can be reduced significantly by humanitarian demining practices. Such practices simultaneously conserve natural resources and increase yields which results to sustainable land management. Mine Risk Education which is a major component of humanitarian demining, will have a lasting impact on people's knowledge, attitudes and practices related to landmines making a positive contribution towards sustainable land management. This paper utilizes research publications from refereed journals and mine action authorities as well as ground information using the systematic literature review (SLR) method. The study investigates relations between humanitarian demining and sustainable land management in post conflict settings with a classic example from North East Sri Lanka. The practical implications for demining operators are that they can implement the strategies to improve the prevailing sustainable land management conditions of the communities in Sri Lanka and elsewhere.

Keywords: sustainability, landmines, humanitarian demining, land release, post clearance, antipersonnel mines

1. Introduction

Land is the most essential natural resource for the survival and prosperity of humankind and other living beings in the planet earth (International Organization of Supreme Audit Institutions [INTOSAI], 2013). Today, there is enormous pressure on land resources such as soil, water and biodiversity predominantly in developing countries (Lefroy et al., 2003). The pressure on land is due to growing world population (Motavalli et al., 2013; Rulli et al., 2013), the need to increase production of nutrients (Glenn et al., 2008; Smith, 2010), and the need to increase agricultural intensification land (Tilman et al., 2002; Rulli et al., 2013). The decline in reserves of quality arable land for urban and industrial use challenges forestry, watershed management, maintenance of biodiversity etc. (Scherr & Yadav, 1996). Hence, there is an urgent requirement to develop sustainable land management to minimize widespread resource degradation from poor land use practices. What is described above is a typical scenario of a land in an ideal setting which is subjected to considerable attention of researchers, practitioners, and policy-makers over the years.

The land in post conflict setting is quite different due to its unique presence of landmines which pose a major threat to current and future land use. Traditionally, landmines were used primarily for defensive purposes and route denial, however, in the modern world they are also used as an offensive weapon. Landmines continue to play a significant role in affecting land access subsequent to the end of war. According to Unruh et al. (2003) large areas of agricultural land remain uninhabitable and hence abandoned for long periods due to mines. Humanitarian demining is introduced as a solution to eliminate landmines and create sustainable land management in post conflict areas. Humanitarian demining is introduced by the United Nations' International Mine Action Standards (IMAS), considered as an effective way of creating sustainable land management in post conflict areas through successful elimination of landmines.

Based on literature available in the web of science, there are many articles treat sustainable land management but not even one percent include post conflict settings and landmine aspects vice versa hardly any articles treat impact of landmines address how to manage post conflict land sustainably. Berhe (2007) while highlighting this imbalance points out that there is a lack of articles based on comprehensive studies on landmine problem in

broader environmental context. Furthermore, landmine crisis possess unique characteristics that influence health of the environment, land in particular and livelihood of the people in a region (Hanevik, 1998). This suggests a need to study sustainable land management in post conflict setting, rather than simply relying on studies of sustainable land management in other contexts.

In studying sustainable land management, choice needs to be made on how to approach the phenomenon of sustainable land management in landmine contaminated areas. Accordingly, a valuable first step in generating increased understanding of humanitarian demining is to map the different approaches used in existing research. This review is, therefore, directed towards answering the main questions: what is the impact of landmines and explosive remnants of war (ERW) on land and how is the phenomenon of sustainable land management approached through humanitarian demining, and what implications do choices of approach have on the development of the field? In addressing these questions, the extent and content of sustainable land management in post conflict area research is analyzed, and ways to continue to develop our understanding of sustainable land management in post conflict areas are discussed.

Based on a systematic literature review (SLR) (Tranfield et al., 2003), environmental impacts of the landmine crisis is presented in accordance with principles and definitions of sustainable land management. This review contributes to the sustainable land management (SLM) literature and to SLM research focused on post conflict settings with special attention to Sri Lanka and identified research gaps to be addressed in the future. It contributes to the field by mapping the current state of knowledge on landmine clearance, resettlement of internally displaced persons (IDPs), and livelihood of the returned community in demined land in Sri Lanka and by articulating and discussing recommendations for effective sustainable land management further. Finding of this study will be instrumental for demining industries, military officials, academics and policy makers and will add to the project management growing body of knowledge.

2. Methodology

This study was carried out according to SLR method, to identify research gaps for more in depth investigations. The paper primarily focuses on research that evaluates and models the factors of landmine contamination and humanitarian demining that influence sustainable land management.

For the purpose of this study, the following online sources were used: Elsevier Online Database (Science Direct), Emerald Insight, Sage Publications, Springer Link, Taylor & Francis and Wiley Online Library. Additional searches were made in the United Nations database, Sri Lanka National Mine Action Centre database, Geneva International Centre for Humanitarian Demining publications and Journal of ERW and Mine Action since it was expected to find relevant grey literature (Juricek, 2009), i.e., studies published outside academic journals, but released by relevant sources.

3. Literature Review

3.1 What is Land?

Land is the original source of materials needed for all nature, living and lifeless. It is not about soil or surface of the earth, but all resources that nature has created on the surface of the earth, its minerals, its water and below the earth's surface renewable or nonrenewable. It includes oceans, lakes, rivers, mineral deposits, rainfall, water-power, fisheries, forests and other numerous things which nature provides and humans use (Todorvski, 2011). Land, a source of production of immense importance to people of all social levels, which place an emphasis on building people's endowments of assets so they can enjoy sustainable livelihoods. This is especially true in the case of poor peasants living in remote areas (Coomes et al., 2011). Social, cultural and economic aspects of their lives are closely interwoven with the land. Thus all aspects of income opportunities and ecosystem services i.e., agriculture, trade and industry are generally influenced by land. Land is a limited resource with increasing substantial demands placed on it. Therefore, land must be preserved to ensure support to continue human activities on a sustainable basis (Radeloff, 2012).

3.2 Sustainable Land Management

Throughout the world land is under intense pressure. Due to the increasingly heavy pressure on land resources, agricultural production declines and the quantity and quality of water deteriorates. Moreover, loss of biodiversity, loss of fertility, deforestation, desertification, salinization and pollution are major effects of increasing competition for access to land (FAO/UNEP, 1999). Therefore it is extremely important to practice sustainable land management as the future generations cannot practically survive without benefits they reap from land resources.

Sustainable land management is an integration of land, water, biodiversity and environmental management. It

ensures that achievement of livelihoods interests goes along with sustenance of the environmental services. World Bank (2006) defines Sustainable Land Management (SLM) as a knowledge-based procedure that helps integrate land, water, biodiversity, and environmental management (including input and output externalities) to meet rising food and fiber demands while sustaining ecosystem services and livelihoods. According to FAO (2015), sustainable land management is crucial to minimizing land degradation, rehabilitating degraded areas and ensuring the optimal use of land resources for the benefit of present and future generations.

Land exists different forms: wetland, forests, farm land, urban land, cultural sites, historical places and conservation land. Recent urbanization and industrialization had caused problems with regard to the availability and productivity of land in a big way. This situation has highly worsened to a near irreparable level in areas where armed conflicts have taken place. There is a very specific correlation between land and conflict; they meet each other on every point of the cycle of the armed conflict and in the post-conflict period. There is an identified need to ensure that land in post conflict setting has to be properly managed due to its "specific" nature. Relatively, post conflict land is complex, and enormously difficult to manage with remaining legacies of war. According to FAO, (2005) the general characteristics of the post conflict environment is death and injury, hunger and starvation, displacement of people, negative social and psychological consequences, changes in values and expectations, destruction of infrastructure and housing and limited funding. The application of weapons, the destruction of structures, fires, military transport movements and chemical spraying are all examples of the destroying impact war may have on the land. Air, water and soil are polluted, animals are killed, and numerous health affects occur among those still living. However, the situation is highly aggravated if landmines and explosive remnants of war (ERW) have been used in the conflict as they pose a major threat to the land use in post conflict environments. Landmines are controversial because they remain dangerous after the conflict in which they were deployed, killing and injuring civilians and rendering land impassable and unusable for decades.

Haveing said that, there is a paramount need to make this land suitable for human resettlement. Sustainable land management can be achieved when landmines are eliminated from the ground as psychologically people are geared to restart livelihood activities. Development process begins only after that place is safe to live. People will become confident and start working towards development with their livelihood activities.

3.3 Landmines: Impact on Land

Landmines, military equipment and abandoned munitions, unexploded ordnance and other ERW pose an ultra-hazard to people in more than 82 countries. For example, Laos, Afghanistan, Mozambique, Bosnia, Cambodia, Iraq and Angola are mostly mine affected countries. In such countries landmines are standing as weapons of terror for local civilian populations, confronting with the threat, depriving them of access to farmlands, roads, and even necessities such as drinking water and firewood. The International Campaign to Ban Landmines has sought to prohibit their use, culminating in the 1997 Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Antipersonnel Mines and on their Destruction, known informally as the Ottawa Treaty. The UN estimates that with current technology, it will take nearly 1,100 years to clear all the mines in the world (Yinon, 1999).

Landmines and UXO are arguably the most toxic and extensive pollution facing the mankind. Landmines are usually laid to demoralize and slow down the progress of enemies. The wide use of landmines has created a humanitarian and ecological crisis due to the most environmentally destructive aftermaths of war. Landmines cause death if not severe physical injury. A study undertaken by Berhe (2006) classified the ways in which landmines cause land degradation into five groups: access denial, loss of biodiversity, micro-relief disruption, chemical contamination, and loss of productivity. The fear of presence of even a single landmine can deny people access to farmland, water, forests and residential areas. The study further indicates that landmines are used in large quantities around arable lands, pasturelands, forests, coastal areas, and infrastructure, commercial and public centres in Lebanon, Angola, Sinai, Iraq, Nicaragua, Korea, Kuwait, Vietnam, Zimbabwe, Ethiopia and Serbia. Landmines prevent farmers from entering in their fields: the population leaves and the land are left fallow for years on end. The declining availability of safe land is subjected to heavy application of mechanical, chemical or biological supplements to increase agricultural production systems. These practices could endanger the health of the soil due to rapid exhaustion of the soil's mineral nutrient stock due to nonstop cultivation, mechanically concentrated agriculture and excessive use of chemical supplements and their consequent accumulation in the ecosystem. Landmines do not discriminate between human beings or other life forms as long as they receive sufficient weight to be activated (Westing, 1996; Dudley et al., 2002). Landmines can be a threat to biodiversity because due to explosions, animals fall victim and vegetation cover gets destroyed as a result. Landmines create an additional burden for endangered and rare species. Which have pushed various species to

the edge of extinction (Troll, 2000). Landmines are accused of threatening extinction of elephants in parts of Africa and in Sri Lanka, and leopards in Afghanistan (Berhe, 2006). Nacho´n (2000) found that presence of landmines is a major threat to considerable number of species in migratory paths according to biodiversity data from the World Conservation Monitoring Centre. Troll (2000) highlights that landmines cause slow death of plant populations because trees could contain shrapnel injuries or abrasions of their bark or roots when fragmentation mines detonate, providing an initiation for wood-rotting fungi.

In terms of micro-relief disruption, landmine explosion damage the soils' stability by crushing the soil structure, and increasing the susceptibility of soil to erosion. Deterioration of soil structure due to explosion, can be a slow process, but the result in long-term have significant impact on moisture, quality and productivity of the land (Berhe, 2006). A harmful practice is reported by Troll (2000) is the use of air craft bombs dropped from the sky that are propagated into the ground and a lot of organic pollutants (from the fuel and the explosive material) get into the soil. Berhe (2006) reports that landmines interfere with the ability of the soil system to serve as a geochemical sink for contaminants while Gray (2007) adds landmines can pose a serious pollution threat accumulation of non-biodegradable toxic waste of casings or unexploded remnants depending on density, composition, type, length and amount and degree of exposure of resources to the mines. Generally, post conflict regions are left with a massive volume of explosive remnants of war that spoil the aesthetic quality of land.

The landmine and ERW contamination can be disseminated directly or indirectly into soil, water bodies, microorganisms and plants with drinking water, food products or during respiration. These pollutant compounds can leach into subterranean waters and bioaccumulate in the organs of land animals, fish and plants. Their effects can be mortal to some mammals and aquatic macro- and micro-organisms by acting as a nerve poison to hamper growth (Organization of American States, 1999; Troll, 2000). All mentioned above sums up to loss of flora and fauna diversity and land degradation—loss of productivity of previously productive land.

3.4 Humanitarian Demining

In post war context, it is linked with humanitarian demining as the latter aims at bringing about sustainable land management and a balance of interests at local and landscape levels. Humanitarian demining is aimed at safeguarding people living with the threat of landmines. International Mine Action Standards [IMAS], (2013) defines demining as activities which lead to the removal of mine and explosive remnants of war hazards, including technical survey, mapping, clearance, marking, postclearance documentation, community liaison and the handover of cleared land. Landmine clearance serves as a vehicle for addressing challenges such as food insecurity, climate change, economic stagnation, biodiversity degradation, and land use conflicts, among others, at local and landscape levels. As such, humanitarian demining is a tool imperative for ensuring sustained land management and hence sustainable rural development.

Humanitarian demining is conducted by the military, international non-governmental organizations and commercial companies with the assistance of Governments, public funding and private funding. Walsh & Walsh (2003) state that costs of producing a mine ranges from US$ 3 and US$ 75, but the cost of removal is high as US$ 300-1000 per mine.

In 1996, United Nations Mine Action Services (UNMAS) together with Geneva International Centre for Humanitarian Demining (GICHD) and support from technical experts from international, governmental and non-governmental organisations developed international standards for humanitarian demining programmes worldwide in order to improve safety, and efficiency in demining by promoting the preferred procedures and practices at both headquarters and field level. Since then, these IMAS are reviewed and revised regularly to reflect developing mine action norms and practices and to incorporate changes to international regulations and requirements. IMAS provides the framework of standards and guidelines which, together, harmonise the manner in which activities and tasks are conducted by the different organizations and agencies involved. Based on the IMAS, mine affected governments develop national mine action standards (NMAS) according to specific country setting and environment with the support of UNMAS.

In the immediate aftermath of conflict, common sense principles and procedures recommended in IMAS can be applied until NMAS is implemented. Whenever possible, standards covering safety and occupational health and the protection of the environment can be applied judiciously, and information on the location of mine and ERW hazardous areas, casualties and technical details on the mines and ERW found can be shared and recorded in a systematic manner.

Each demining operator should have a "Standing operating procedures" (SOPs) which define the preferred or currently established method of conducting an operational task or activity. The purpose is to establish recognisable and measurable degrees of discipline, uniformity, consistency and commonality within an

organization, with the aim of improving operational effectiveness and safety. SOPs should reflect local requirements and circumstances (IMAS, 2013). It is recognized that the United Nations has a key role to play in articulating this global response, and in providing the necessary international support and coordination mechanisms for mine affected countries.

Humanitarian demining methods are technically referred to "Land Release" which consists of manual and mechanical assets including human, dogs and rats. Land release is an effective application of nontechnical survey (NTS), technical survey (TS) and clearance activities to identify, define and remove the threat of landmine and ERW contamination (Gray, 2015; Bach, 2015). These methods are used to identify mine and ERW contamination and return safe land to productive use. Land release is a decision making process which systematically prevents full clearance of land when the less expensive, more rapid NTS or TS methods could be employed to cancel or reduce suspected hazardous areas. Bach (2015) mentions that the basic approach of land release is to apply all reasonable effort to identify and subsequently release all confirmed hazardous areas by using an evidence based survey approach with minimal disturbance to the environment.

Nontechnical survey is the first step of land release process to collect and critically analyse essential information from a broad range of stakeholders in affected communities without the use of technical intervention to determine evidence of the presence or absence landmines and other explosive hazards. This method also involves mapping suspected hazardous areas by reasonably drawing polygons around areas with evidence of mines (Gray, 2015; Bach, 2015). This map is used as a guide for demining plan which is edited and updated regularly when more credible information available during clearance. Bach (2015) states that TS is detailed with the use of technical assets that can detect the presence of mines and ERW. Technical survey follows up NTS polygons and defines them to further smaller and accurate CHAs that require clearance and investigate buffer zones around cleared areas and release land within CHA polygons. Basically, TS experiences the likelihood of mines emplaced patterns and the type and nature of mine laid patterns. Bach (2015) further explains that inside a CHA the basic principle is to search the area until mines are found, which is where clearance starts and proceeds to the front and sides, following the mine patterns if they exist. In case, mines are not located, sufficient TS must be applied to establish enough confidence to cancel the area.

However, land release method does not assure hundred percent removal of mines and other explosive remnants. It only minimizes the probability of having such items. Nevertheless, people live in areas where humanitarian demining has been carried out have to be cautious of the fact that low probability does not mean improbability. Still there is a probability of having dangerous items buried and those who live in these areas should be educated on how they should adjust their lives, livelihoods and other activities so that the risks that they are facing are minimized ideally to a near zero level. This can be achieved by educating such people with regard to possible risks they may face and how to act when they confronted with situations involving landmines and other explosive remnants of war. This educational process is known as Mine Risk Education (MRE) and is practiced in many countries where the war has prevailed for a long period of time.

IMAS (2014) defines MRE as activities that seek to reduce the risk of death and injury from mines and ERW by raising awareness and promoting safe behaviour. These activities include information exchange with at-risk communities, communication of safety messages to target groups, and support for community risk management. The objective of MRE is to reduce the risk to a level where people can live safely, and to recreate an environment where economic and social development can occur free from constraints imposed by contamination. (Geneva International Centre for Humanitarian Demining [GICHD], 2014)

Humanitarian demining and mine risk education are inseparable entities as prerequisites for sustainable management of land resources in post conflict settings. Evidence exist showing that the intended goals of land use planning become more efficiently achieved when all stakeholders including government, researchers, and decision makers participate in eliminating landmines in mine-affected areas.

3.5 Sri Lanka Case

3.5.1 History of Civil War

Sri Lanka sets a practical example for this study as the country experienced over 30 years of civil war which ended in 2009. The Liberation Tigers of Tamil Eelam (LTTE), a separatist group in Sri Lanka, since 1983, has been fighting against the government of Sri Lanka in an effort to create an independence state for the Tamil people (Sutton, 2012). After the outbreak of war numerous attempts at peace negotiations and ceasefires were interspersed with further conflict eruptions. Victory was declared in May 2009, after the Sri Lankan government captured the last LTTE stronghold in North and East provinces after a massive military offensive.

In 2002, subsequent to the ceasefire agreement, humanitarian demining officially started in the country but in the escalation of the conflict in 2006 lead to considerable fresh mine/ERW recontamination. With the cessation of hostilities in 2009, and with the Government's prioritization of resettlement of approximately 300,000 internally displaced people (IDP) in the North East, demining has seen an exponential scale up of activities. Currently, people are resettling in post clearance areas while demining is in progress in the North East regions. North East areas were predominantly by standers in the war; after clashes took place, regions were abandoned by the fighting forces as they moved onto the next stage in the campaign. With the end of the war, Sri Lankan government forces were withdrawn. However, the residents were prevented by the government from returning to their home to avoid possible deaths and injuries due to landmines and explosive remnants of war (ERW). Soon after the war, a large number of key military bases were removed from the areas. However this was not accompanied by removal of remnants of war, both explosive and otherwise, were left scattered throughout the area without conforming to general procedure of leaving military bases (Sri Lankan Ministry of Economic Development, 2010).

After the conflict, the Government of Sri Lanka along with international and local demining agencies had reengaged in the surveying and clearance procedures of the demining process. The clearance was prioritized in residential areas, agricultural areas and finally forests. Currently, the agricultural areas are being released to the people. The people who have resettled in the areas of origin have already started farming. (National Mine Action Centre, 2016) However, according to Landmine Monitor (2015), Sri Lanka estimates of total mine and ERW contamination have fallen sharply, from 506km2 at the end of 2010 to 98km2 at the end of 2012 and 78km2 at the end of 2014 and 63km2 at the end of 2015 (see table 1 below). There are still unidentified areas for demining in Sri Lanka (the above sentence is based on a personal communication first author of this paper had with the Operations Officer of Regional Mine Actoin Office Sri Lanka Dilhan Iddamalgoda, 2016). The Department of Wildlife Conservation proposed 16 new wildlife reserves for the Northern Province but some of them are still mined. The complete level of the mine/ERW contamination is not yet known, but as at December 2015 all districts in the North East have been surveyed to some extent, and it is expected that by the end of 2020 the clearance will be completed. During clearance, more than one million landmines, UXO and other explosive remnants of war have been located and removed (Sri Lankan National Mine Action Centre, 2014).

Table 1. Remaining confirmed hazardous area (km²)

District	End 2012	End 2013	End 2014	End 2015
Jaffna	4.16	3.81	3.08	2.30
Kilinochchi	19.45	18.06	17.05	16.32
Mullaitivu	20.14	16.18	13.59	10.57
Vavuniya	7.22	5.08	4.60	4.26
Mannar	25.99	16.50	15.60	7.90
Trincomalee	3.41	6.38	6.38	3.99
Batticaloa	14.67	14.40	14.38	14.33
Ampara	0.07	0.07	0.06	0.06
Anuradhapura	3.35	3.33	3.32	3.32
Polonnaruwa	0.19	0.03	0.03	0.03
Total	**98.65**	**83.84**	**78.09**	**63.08**

There are instances that although the deminers assured the people of a safe and conducive environment, the resident still fear attacks by the landmines and UXO in their surroundings. Having said that collecting scrap metal is a deadly economic activity borne of the need by poor to make a living. The collectors of remnants of old ordnance ignore the danger purposely.

Communities continue to live among these increasingly unstable and dangerous relics, such as antipersonnel mines, and other ERW that have begun breaking apart and polluting the soil and environment. People have been resettled in certain areas after clearing the areas of landmines, yet the danger is when people wonder in the forest areas which are not yet been mapped under the mine evacuation operation. It is unavoidable that people enter forest areas to meet certain needs related to daily chores and livelihood activities and children enter forest areas to play and there are still some incidents where people continue to be killed or maimed due to activations of mines.

3.5.2 Mine Laying Patterns

In order to ensure the greatest possible effect, minefields are typically emplaced in definite at least predictable patterns in mine affected countries. According to Moore (2016), the South African minefields are similar to Zimbabwe, Mozambique and Nambia following a predictable pattern of a center-row of antitank mines five meters apart protected by two antipersonnel mines nearby in the ten and two o'clock positions towards the likely approach. A study undertaken by Roberts & William (1995) stated that mines placed in rows through fields in Bosina-Herzegovina and Croatia with a few nuisance minefields. The study further mentions that mines are mostly been laid sometimes in organized patterns in Afghanistan, Cambodia, Iraq, Libya, Somalia and Vietnam.

Mine laying pattern is a unique feature in Sri Lanka. Landmines were used to varying degrees by both sides at different stages of the conflict and continue to present an obstacle to the safe return of displaced families (Kumarathasan, 2004). Both sides made extensive use of mines, tripwire-activated Claymore-type mines, and to a lesser extent antivehicle mines mostly belts of P4 MK1 blast antipersonnel mines laid by the Sri Lanka Army and long defensive lines with a mixture of mines and improvised explosive devices (IEDs) laid by the LTTE (Landmine Monitor, 2015). According to the Sri Lankan Ministry of Economic Development (2010), Sri Lanka Army emplaced landmines in a specific marked pattern. Landmines were laid in protective minefields according to patterns and were recorded during the laying process. The government claims that all mines laid by the security forces were in accordance with the provisions of the Convention on Certain Conventional Weapons. The government claims that minefield records were handed over to the demining authorities at the end of the war and entered into the Information Management System for Mine Action (IMSMA database) for utilisation during survey and clearance activities (Sri Lankan Ministry of Economic Development, 2010).

LTTE created protective minefields according to patterns, but there are no minefields records available. Most mines of LTTE are of the anti-personnel type, sometimes laid in dense, patterned mine belts, but there is also random, unmarked widespread nuisance mine-laying in residential areas to prevent access to facilities, shelters, wells and food. These nuisance mines consist of single mines scattered over large areas, in bushes and multiple mines laid together to protect specific access routes. During the latter stages of the conflict mines were also thrown openly on the ground and dropped explosives in water wells. The LTTE used improvised explosive devices (IEDs) in the form of mortar shells connected to tripwires to act as fragmentation mines, electrical initiated explosive devices placed at strategic locations, mines connected with detonating cord to mortar/artillery shells a distance away, etc. The LTTE manufactured mines with an anti-lift/anti-tilt mechanism to prevent the removal of the mine from the ground after it is was laid (Sri Lankan Ministry of Economic Development, 2010).

If the mines are laid in patterns, density was known and minefield information was available, humanitarian demining approach would have been cost effective and expedited. Due to poor mine laying patterns and unknown hazardous areas makes the size of contamination appear more or less extensive than it is in reality and leads to the disproportionate use of TS and clearance resources. This situation subjects to excavate safe land unnecessarily which challenges Sustainable land management.

3.5.3 Land Use System and Practices

The land of the North and East Sri Lanka is relatively flat and of low elevation towards the coast. (Northern Provincial Council, 2014) Agriculture is a major source of livelihood and export revenue (Teare et al., 2013). While it is pre-dominantly an agricultural region having crops, soil is well suited for particularly paddy cultivation. The statistics from Northern Provincial Council (2014) reports paddy harvesting reached the level of 217,149mt and the Province was able to supply its surplus to other parts of the country while 56,277 ha highlands of annual crops, perennial crops and homesteads cultivation.

Livestock, animal husbandry and fisheries are pivotal subsectors. Livestock is considered as an additional source of income for the farming society in the region. According to the records of Northern Provincial Council (2014), average milk production reached 70,063 liters per day and meat production reached approximately 20,000 Kg per day in 2013. The region is rich in mineral sources and sand dunes, to quarry metal and clay forbricks and tiles and beach mineral sand needed for construction. Some scientific option of possible oil deposit off the Gulf of Mannar has not been fully explored yet. There are important ecological coastal features such as Lagoons, bays, salt flats, wetlands, coral reefs, islands and islets. Traditional water supply is through built irrigation tanks as there are limited streams and rivers. The North and East area compromise 40% of the country's coastline, and has immense potential for fisheries and aquaculture. The wildlife areas and extensive forests contributes to biodiversity and tourism (Northern Provincial Council, 2014).

3.5.4 Priority-Setting in Mine Clearance

A significant proportion of the available agricultural land in Sri Lanka cannot be used because it is contaminated by mines and UXO. According to the priority setting scheme of National Mine Action Centre (2010) residential areas of villages identified for resettlement, livelihood areas, giving access to schools, hospitals and religious centers, or within three kilometers of villages and main roads was considered high priority. It assigned medium priority to land needed for agriculture infrastructure development and low priority to hazards in jungle areas with no immediate impact. It would have been ideal that the areas used for agriculture, livelihoods and lands containing socio-economic infrastructure are cleared in parallel as people are returning to their homes. The priority-setting was done due to limited demining capacity available in the country comparing to scope of contamination. Sutton (2012) points out that the returnees have to live near or next to mine and ERW contaminated land. The contamination blocks access to vital agricultural land, surrounding land, including gardens and rice farms, hereby preventing people to effectively re-engage in livelihood activities, as well as to have access to firewood. As a result people ignored clear demarcations of un-cleared dangerous area to meet their basic needs and livelihood requirements and some lived on humanitarian support or encroached on safe land belonging to someone else to meet their food and security needs (Sutton, 2011; NMAC, 2010; Naidoo et al., 2011). A case study of Naidoo et al. (2011) shows that there has been lack of proper information sharing about the return and resettlement of internally displaced persons (IDPs) by Sri Lankan authorities. Therefore, rumours spread among the IDPs about the return process and access to land. As a result, some IDPs returned to find that while their residential areas have been released, their farm lands remained contaminated, forcing them to rely on food aid or farm in lands which were not under their ownership. (Naidoo et al., 2011)

3.5.5 Mine Risk Education

For years, mine risk education (MRE) has been a central component of humanitarian demining activities in Sri Lanka (UNICEF, 2011). Key to communicating the dangers posed by the presence of mines and ERW, risk education can significantly reduce the risk of accidents in clearance/post clearance areas. According to IMAS (2004), the objective of MRE is to reduce the risk ensures safety of the communities living in the former conflict zones, and to refabricate an environment where economic and social development can occur free from constraints imposed by landmines/ERW. MRE is defined as a pre-requisite to minimise the risk of death and injury from mines and ERW by raising awareness and promoting adoption of safe behaviour. The process includes information exchange with at-risk communities, disseminating safety messages to targeted groups to support physical and psychosocial well being of survivors IMAS (2004).

Sri Lanka established a low-cost MRE approach via the national education system, UNICEF and a few demining agencies. UNICEF developed a standard and a policy for MRE jointly with the Government and NGO stakeholders. (Ministry of Economic Development, 2010) The MRE operators used different communication strategies to reach their audience. MRE shares data on casualties and suspected hazardous areas, prepare mine risk education materials, provide community and school-based mine risk education, and develop village clearance maps (U.S. Department of State, 2012). MRE operators use array of tools and techniques to allow a tailored approach for delivering key messages to various groups (age, gender, profession) in communities. These range from formal presentations for community based organizations, school presentations, and focus group discussions with farmers to house-to-house visits with rural women. (Swiss Foundation for Mine Action's presentation, 2016). In addition to school presentations, government education authorities decided to integrate MRE into the national curriculum as a compulsory subject since year 2011. Accordingly, MRE is taught within the "Environmental Studies" unit in the primary grades and the "Life Skills and Competencies" unit in the secondary grades of children (UNICEF, 2010).

Ministry of Economic Development (2010) has gained significant experience and seen firsthand positive impact that MRE can have on people still suffering from the effects of conflict. MRE has resulted to improve general levels of understanding the mine/ERW threat and knowing what to do in case of encountering mines and ERW in the Northern and Eastern Province. Many people demonstrated intelligent behaviour by reporting suspected dangerous devices and areas to the relevant authorities while further educating their community and travelers about the existing threat.

Mine action literature is not, in general terms, well stocked with quality literature although there are a number of noteworthy exceptions. With such a short timescale for the development of theory of humanitarian demining (i.e., the 13 years of operations since the first humanitarian mine clearance in Afghanistan), and with such a diverse catalogue of countries in which programmes are operating, the studies undertaken to analyse the humanitarian demining models are limited. Papers that deal primarily with sustainability, landmine detection, landmine

characterization, victim assistance and stockpile destruction have been excluded. This study highlights instances from Sri Lanka as the country is experiencing the resettlement and development stage subsequent to mine clearance activities in most affected areas in the northern region.

4. Discussion and Conclusion

This review has sought to investigate the extent and content of research into sustainable land management in post conflict settings, identifying different humanitarian demining methods, and discussing implications to improve the current status of sustainable land management. The aim is to highlight the importance in initiating a research to address sustainable land management in post conflict settings. This objective was achieved by combining the items of highly cited papers from various journals to nonacademic journals in the field. This selection of journals invokes a certain bias due to limiting the literature search to a set of journals. The researchers see this as a necessary step to scope the research process and limit the total number of papers reviewed to a manageable amount.

With the exception of articles on impact of landmines, sustainable land management in war torn areas, or its implications, is not explicitly discussed. The choice of demining method constitutes a central issue influencing strategic decisions such as selection of research questions, research design and results, and, therefore, must be considered carefully. The land in post conflict areas has to be treated differently and humanitarian demining has a vital role towards creating sustainable land management. Sri Lanka sets an interesting example for a potential study as the livelihood has started in cleared lands while demining is still going on in a few agricultural land and forests. It is essential to find the best and most suitable method for demining to ensure sustainable land management in Sri Lanka. The chosen approach should make minimal disturbance to the land to remove a mine. The use of machines in Humanitarian Demining should be limited as they are rarely cost-effective, environmentally friendly, or sustainable. The techniques of manual mine clearance currently employed in Sri Lanka by utilising a metal detector, by full area excavation using hand tools and by rake excavation detection system (REDS) should be promoted in spite of its slow process. According to SLNMAS (2010), the average depth of excavating earth to locate mines shall be 15 cm from ground surface level. GICHD conducted comparative trials of Sri Lankan manual demining systems and found successful, in Mozambique (Smith, 2005). It would be useful to gain a better understanding of why certain demining approaches are applied, but this would require deeper analysis involving interviewing the demining operators, which is beyond the scope of this review.

It is important to integrate and standardize mine risk education as a key role in humanitarian demining process so that it helps mitigate the fear of residents whose lands have been cleared. MRE programmes should provide MRE and training for community members and volunteers, and link humanitarian demining and the affected communities to ensure the awareness of threats posed by mines/ERW. The MRE teams should be aware about the contamination and provide relevant information to the returnees who restart livelihood in post clearance areas. The paper suggests to incorporate implications of social theories in relation between the individual and social in terms of mine risk education. (DeVries, 1997)

A lack of literature exists between the connection in humanitarian demining as a key component of sustainable land management and the limited research into demining and the uncertainties arising from the complexity of the post conflict setting phenomenon, justifying a need for more research focusing particularly on impact of mine clearance activities on sustainable land management. The approaches identified here could all constitute starting points for empirical research in post conflict settings. At a more specific level, to further increase the understanding of sustainable land management in war torn areas, the call for more qualitative in-depth longitudinal studies of sustainable land management in war torn areas made by various scholars needs to be taken seriously and carefully considered when designing future research projects.

The findings of this review suggest that a framework has to be developed which reflects the suitable humanitarian demining practices to ensure sustainable land management in Sri Lanka which will produce more variation in research questions, designs and results, likely expanding our understanding of sustainable land management in war torn areas. The absence of consensus and uniformity on demining methods in mine affected countries may be an indication of not considering the impact on sustainable land management. Alternatively, it may suggest that a particular demining method does not, due to the nature of the phenomenon, fit into any mine affected country. The methods can vary due to the climate, density, soil, size of contamination and type of hazards. The framework should stand as a model to use in other mine affected countries as well to analyse the impact of humanitarian demining on sustainable land management.

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