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This is a so-called personal version (author's manuscript as accepted for publishing after the review process but prior to final layout and copyediting) of the article: Sarkis, J, Spens, K & Kovacs, G 2012, 'A study of barriers to greening the relief supply chain'. in G Kovács & KM Spens (eds), *Relief Supply Chain Management for Disasters: Humanitarian Aid and Emergency Logistics*. *IGI Global, Hershey, USA*, pp. 196-207., 10.4018/978-1-60960-824-8  
<http://www.igi-global.com/chapter/study-barriers-greening-relief-supply/55200>

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# A Study of Barriers to Greening the Relief Supply Chain

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## **ABSTRACT**

Relief supply chain (SC) management is a relatively unexplored field. In this field, practitioners have shown some interest in greening practices, but little practical or academic literature exists to help provide insights into combining the two fields. Adoption of green SC principles in the relief SC requires a systematic study of existing barriers in order to remove these barriers and allow introduction of green practices. The aim of this chapter is to explore barriers to implementation of green practices in the relief SC. Expert opinions and literature from humanitarian logistics and green supply chain management are used to establish a list of barriers and to propose a categorization of barriers. Further research to evaluate the relationships and importance of these barrier factors is identified.

## INTRODUCTION

Supply chain management requires the planning, design, implementation, coordination and maintenance of various flows across many boundaries. Supply chain social responsibility has received increased interest over the past decade. One aspect of socially responsible supply chains includes their application and management for humanitarian purposes. Another important dimension of the socially responsible supply chains is the greening aspect, or green supply chain management. Separately these two topical disciplines have seen a paralleled growth and interest by practitioners and researchers. Even though numerous researchers have been investigating sustainable supply chains, where the term sustainable includes social, economic, and environmental dimensions, it is surprising that the intersection of these inchoate fields has yet to be carefully examined. Therefore, in this chapter the two fields, green supply chain management (GSCM) and relief supply chain management are integrated through a study on barriers to greening the relief supply chain.

Relief supply chain management is a relatively new area of investigation which is typically associated with unexpected disasters that require immediate action. As stated by Kovács and Spens (2007), recent humanitarian logistics literature also focuses on disaster relief, yet, most relief supply efforts can be attributed to longer term effects, especially those situations which result from war and famine (Hoerz, 1997). One good example is refugee camps, which may last for years and need effective long-term and short-term operational planning. The burden on the environment is of such a magnitude that comments such as “the UNHCR [aka The UN Refugee Agency] has destroyed our environment” have been cited (Hoerz, 1997). A general list of potential environmental impacts associated with water and related activities in a camp situation include the

- Depletion of the source as a result of unsustainable extraction or collection of water.
- Contamination of the local water due to improper disposal of waste water and human-waste, faulty design and operation/maintenance of the piped water network, excessive extraction of groundwater and other related activities in the camp.
- Impacts to local environment due to construction and operation of water supply system intensity and magnitude of which would largely depend on the nature and size of the project and the sensitivity of the local ecosystem.
- Inappropriate drainage, soil and water conservation measures as well as poor water management in irrigation systems may lead to erosion, floods, groundwater contamination and soil salinization.
- Camps or settlements close to open streams or over unconfined aquifers may cause downstream contamination.

Inside Haiti, more than two months after the 2010 earthquake, it was reported by the BBC that some areas had yet to receive humanitarian supplies. When some of these supplies arrived in a community not too far from the epicenter of the 2010 earthquake, they came in many forms. One set of supplies included military rations (Meal, Read to Eat, MRE). These rations were culturally inappropriate due to their 'individual' nature and containing non-traditional, to Haitians, foods. It was expected that many of these MRE would be discarded. Important from an environmental perspective, is that these MREs came in hard plastic containers. It was observed in the BBC radio that piles of green plastic, hazardous and not easily disposable, existed as over 250,000 MREs were delivered to Haitians. Given this type of scenario, one suggestion to reduce the impact of camps on the environment has been to involve refugees in the battle against this environmental destruction, something which has been successfully deployed for example by the UN. An example is provided by the Sherkole camp in the western Highlands in Ethiopia where environmental education and awareness is being put into place to help fight climate change (UNHCR, 2009). The other type of situation to which humanitarian logistics is usually linked is disaster relief operations. Literature suggests that up to 80 percent of the costs involved in relief operations are in fact related to logistics. Not only are the costs of the disaster relief operations high, the impact on the

environment is also severe as in many cases the urgency of the situation enforces the use of environmentally unsound transportation modes and means. Thereby, one aspect of the potential conflict between efficiency in humanitarian logistics and environmentally sound green supply chains is in the selection of modes of transportation for material delivery. If delivery time is a major concern then air transport may be the most time efficient approach. Yet, air transport is between 5-20 times worse in terms of fuel and air emissions than train or road transport and even greater than water transport. This situation is one example of the conflict where planning for relief supply chains and distribution may mitigate the inefficient transportation mode selection problem.

The Office of Coordination for Humanitarian Affairs (OCHA) also promotes preplanning (OCHA, 2007), as they state that environmental considerations should be integrated into physical planning and shelter from the very start of an emergency. They point out that location and layout of refugee camps, provisions made for emergency shelter, and the use of local resources for construction and fuel can have a major negative environmental impact. Planning may incorporate a more efficient design of relief supply chains where distributed management or relief supplies and improved communication networks may actually help impoverished areas socially and reduce the ecological footprint of relief supply chains. We posit that these win-win situations can be more effectively implemented with joint consideration of greening relief supply chains. Another humanitarian event that showed the implications of materials logistics on the environment are occurrences of flooding. For example, when the Red River overflowed along the Minnesota-North Dakota border, millions of sandbags were used to provide protection against the flooding. The sand to fill the sandbags had to travel 30-40 miles to the site where the bags were filled and stacked. After the flooding occurred, the sandbags could not be left there. Communities then take it upon themselves to dispose of the sandbags. The issue of what to do with the sand from these sandbags has environmental implications. Sending the sand back 30-40 miles to its source was not a feasible alternative. Current plans included recycling the sand as part of road construction material. Future considerations to help with materials management have yet to be determined, but more effective environmental plans are needed.”

The chapter will seek to introduce a brief state-of-the research review of issues in each of these fields. We will then identify the various elements of both these fields and discuss how barriers to implementation (organizational and otherwise) may lead to difficulty in their joint implementation. Expert opinions will be used to identify barriers setting a foundation for further research on how these barriers may be mitigated.

## **BACKGROUND AND LITERATURE ON GREEN AND RELIEF SUPPLY CHAINS**

### **Green Supply Chain Management**

This field has evolved over the years from focusing on descriptive works and elements of good practice, e.g. building awareness, to basic theoretical understanding of mechanisms on identifying how to improve the relationships and practices in green supply chain management for competitive and environmental improvements. The green supply chain is defined as supply chain management that has been utilized to mitigate the impact of industrial supply chain activities on the environment.

The supply chain can be described from at least four flows and relationships perspectives, upstream, downstream, internal organizational activities and the closing of the supply chain loop, or reverse logistics. Upstream activities, flows and relationships would include purchasing and procurement topics. Included amongst these topics might be outsourcing, vendor auditing, management and selection, supplier collaboration and supplier development. Internal organizational supply chain activities are generally related to the traditional production and operations management topics of an organization. Managing the flows, relationships and resources inside the boundaries of a stand-alone unit or organization, the

enterprise, is the scope of this dimension. Such activities may include research and design, quality, inventory, materials, and technology management within an organization could each influence environmental characteristics of internal organizational processes. The next juncture of a supply chain focuses upon the outbound and downstream relationships and flows. Activities and functions here may include outbound logistics and transportation, marketing, distribution, packaging, and warehousing. The flows are utilized by downstream customers who may be commercial or individual consumers. Closing of the supply chain loop supply chain activities focus on end-of-life materials will eventually be consumed back into the system with recycling, remanufacturing, reclamation, and reverse logistics all part of this concept.

Evaluating all aspects of the supply chain from an environmental perspective a goal of greening the supply chain. The extensive internal and external relationships that need to be managed within and between organizations is not a trivial task, with additional complexities of managing environmental dimensions in addition to standard business dimensions. These environmental dimensions include various organizational greening practices that may affect standard supply chain management activities. For example, the use of life cycle analysis and design for the environment require close cooperation and collaboration with suppliers and customers. The many activities of the supply chain can be put into practices such as eco-design, supplier relationships, customer cooperation, internal practices, and investment recovery. These practices map to the four areas of traditional supply chain management. The need for greening supply chains arises from a variety of pressures faced by the organization including regulatory, competitive, and community/public pressures. All of these pressures can be related to the competitive and economic sustainability of the organization. The response to these pressures varies, but can be categorized into reactive and proactive responses. The organization may gain various benefits from the responses ranging from very tangible results, e.g. reducing costs and generating revenues, to less tangible results including building reputation and image or having the legitimate right to operate. Yet, the responses are not without their limitations. For example, even if an organization faces significant pressure to green their supply chain, without appropriate coordination, information, and resources the likelihood of the greening implementation is limited.

## **Relief Supply Chain Management**

Humanitarian logistics has during the last few years gained increasing interest in the logistics research community. Until recently only a few articles had been published, however, much due to the poor logistics performance during the South East Asian earthquake and tsunami in 2004, the need for research in the field was recognized. Evidence also points at an increasing number of natural and man-made emergencies worldwide, nevertheless, there is still relatively little work published aimed at improving the understanding of the nature of supply chain management (SCM) in crisis conditions (Pettit & Beresford, 2009). The existing literature in the field has also been quite skewed towards examining immediate disaster response (Kovács & Spens, 2008), whereas the other phases of the disaster response cycle, i.e. mitigation, preparedness and recovery have received less attention. The latest publications in the field of humanitarian logistics indicate a growth in the interest for the other stages as well (see e.g. Richey, 2009).

According to a literature review conducted recently by Richey (2009), key topics in supply chain disaster and crisis management-related supply chain strategy and logistics operations include: agility, risk management/insurance issues, humanitarian issues, inventory management, facility location, collaboration/networks, and multi-level partner/non-partner integration. There is also an issue of whether supply chain management in the business sector can be compared to supply chain management and logistics in the humanitarian arena. They also describe the unique characteristics of the disaster relief environment and compare and contrast humanitarian relief chains and commercial supply chains (Balcik and Beamon 2008). A major conclusion from the literature is that many of the tools and techniques, despite the challenges posed by the differences, used in the commercial arena can be applied in the humanitarian arena. There are, however, also major differences that separate relief SCM and logistics

from its commercial counterparts. The major difference being that relief supply chains operate in an unpredictable, dynamic and chaotic environment (Balcik & Beamon, 2008). In summary, the dominating characteristics that bring additional complexity and unique challenges to relief chain design and management are:

- unpredictability of demand, in terms of timing, location, type, and size,
- suddenly-occurring demand in very large amounts and short lead times for a wide variety of supplies,
- high stakes associated with adequate and timely delivery,
- lack of resources (supply, people, technology, transportation capacity, and money).
- uncertainty
- communications
- degraded infrastructure
- human resources
- earmarking of funds

In addition there are other characteristics of the relief environment that differentiate this area from the commercial area, e.g. the amount of and type of actors in the complex aid supply network and funding constraints (Kovács & Spens, 2007; Balcik & Beamon, 2008). The actors in the relief supply chain involve a diverse group of direct stakeholders including military forces, donor and recipient governments, commercial actors (corporations provide goods and services) and ultimately the end users; the beneficiaries. The actor structure and the number of actors in a relief operation, the complex relations that evolve around them, their different and often conflicting goals and demands lead to problems in setting and prioritizing goals for the whole supply chain or supply network. Issues such as donor pressure and other stakeholder involvement might affect resource allocation and competition for funding might inhibit coordination efforts between Non-governmental organizations (NGOs) and other network actors. In many instances, donors tend to fund NGOs for specific missions or activities relating to their own agendas, which often might not contribute to infrastructure (Balcik & Beamon, 2008). This behavior again encourages the NGOs to focus on operational disaster relief activities rather than disaster preparedness which would reduce expenses or make relief activities more effective over the long-term. So, for example, although access to timely and accurate information is vital for relief organizations, information systems are yet not well-established in the relief supply chain (Balcik & Beamon, 2008).

Even though logistics is central to disaster response activities the aid sector has viewed logistics more as a necessary expense rather than an important strategic component of their work (Beamon & Kotleba, 2006). Only recently have humanitarian relief organizations started to understand the criticality and importance of relief chain management to the success of disaster relief operations. In addition, relief supply chain management also entails longer-term considerations e.g. the provision of food aid during complex emergencies as well as supplying refugee camps, of which some become rather permanent settlements. In these situations the defining characteristics ascribed to relief supply chains are no longer valid. Therefore in longer-term situations, environmental concerns and green practices should be more easily incorporated in relief supply chains in order to mitigate the impacts of the aid operations. Barriers to implementation of green supply chain practices should therefore be investigated in order to help understand and overcome them, both with regards to longer-term aid efforts as well as shorter-term emergency relief efforts. In this chapter, however, the focus is on short-term emergency relief efforts as a first step in exploring the barriers to greening the relief supply chain as the emergency phase is the critical moment at which environmental degradation may be confined or limited and activities undertaken at the early stage of the operation are usually far more cost-effective than those taken later (OCHA, 2007)

## **BARRIERS TO INTRODUCING NEW PRACTICES AND PROCEDURES**

In the supply chain literature, potential barriers or resisting forces have been investigated. Barriers to strategic supply management derive from both the nature of the organization itself and the people that compose the organization (Fawcett et al. 2008). Other barriers to SCM fall under managerial complexity (information system and technological incompatibility, inadequate measurement systems, and conflicting organizational structures and culture) or misalignments in allying firms' processes, structures, and culture. Interestingly, the single greatest barrier that Fawcett et al. (2008) identified in the survey they conducted was information systems. However, when they conducted interviews, human nature was found to be the primary barrier to successful SC collaboration. Unsurprisingly, they also concluded that people are change averse and prefer to maintain the status quo. Human and organizational behavior was at the root of nearly each of the major barriers (i.e. organizational culture and structure, functional conflicts, lack of managerial commitment, conflicting and non-transparent processes, policies, and procedures, performance measurement, information sharing, lack of trust, resource constraints, and complexity of SC networks).

Similar barriers investigation has occurred in other supply chain and operations topics. For example a study on barriers to implementation of agile manufacturing found 11 barriers typically facing agility and agile manufacturing adoption. The barriers included lack of top management support and commitment and fear of organizational change (Hasan et al., 2007). Similar barriers were found in various organizational programmatic studies such as implementation of ERP systems (deVries, 2007). Organizational culture and training of employees were also found to be substantial barriers in these settings. In recent research in the field of green supply chain management concludes that there are different categories of barriers, and names 11 categories of barriers or. In summary, the operations and supply chain literature indicates that the following categories of barriers exist (Sarkis, 2009):

- Informational barriers
- Political barriers
- Proximal barriers
- Organizational
- Economic barriers
- Operational barriers
- Temporal barriers
- Technological barriers
- Cultural barriers

These categories of barriers provide a good basis for exploring barriers in other fields. The barriers are general enough to provide a broad categorization, but there is room to also explore whether there are additional categories that need to be added.

## **METHODOLOGY**

Using a workshop in Canada on humanitarian logistics, logistics experts representing different aid organizations were asked to participate in our study on barriers to greening the relief supply chain. Climate change-related disasters were already mentioned at the workshop, and we briefed the experts that the question in our research would be on the ecological dimension of humanitarian logistics and supply chain management. Altogether 6 organizations (out of 9 asked) participated of which one was not represented at the workshop. The organizations that took part in the study represent different types of aid organizations; UN related (World Food Program, WFP), large non-governmental international aid

organization (Worldvision), secular organization (Canadian Foodgrains Bank), private sector aid initiative (American Logistics Aid Network, ALN), a logistics professionals initiative, (The World Organization for Relief Logistics Development, World) and a government funded GO, (National Emergency Supply Agency, NESAs). The logistics experts from these aforementioned organizations were in the first round asked to list 10 or more barriers through electronic correspondence. The experts all replied by providing at least 10 barriers, in some cases more. Usually the barriers were provided in the form of statements such as “low awareness of technology to reduce carbon footprint”.

The next round consisted of sending out an email to the same experts that included a list of barriers discovered in round 1. This list was compiled based on an analysis of the barriers (usually provided in the form of statements) received in round one. The first step of the analysis involved grouping the barriers. Thereafter the barriers were assigned to the most appropriate categories available from the literature review. If the statements did not fit the category, a remark was made on the statement that indicated a misfit. The misfit usually meant that the category the barrier had been assigned to needed some further refinement or a broadening of the category. In Table 1 an example is provided of the grouping of barriers and their categorization into more general categories.

**TABLE 1**

<b>Informational barriers</b>	<b>Source</b>	<b>Relief SC barriers</b>
Communications Lack of information Lack of communication with other NGOs, GOs  Inadequate knowledge, inadequate data	de Vries 2007 Kovács and Spens 2009,  Sarkis 2009	<ul style="list-style-type: none"> <li>- Low awareness of technologies to reduce carbon outputs</li> <li>- Low awareness of low carbon / green operations</li> <li>- Low awareness of management approaches to reduce carbon footprint</li> <li>- Lack of awareness and knowledge how to handle different materials</li> <li>- Lack of communication</li> </ul>
<b>Organizational</b>	<b>Source</b>	<b>Relief SC barriers</b>
Lack of top management support and commitment  Fear of and resistance to organisational change, resistance of the workforce Poor partnership (supply chain) formation and management Insufficient training, education and rewards system  Poor planning Performance standards, measurement	Hasan et al. 2004,  Hasan et al. 2004  Hasan et al. 2004, Rodman 2004, Whalen & Rahim 1994 Rodman 2004 de Vries 2007  de Vries 2007  Kovács & Spens 2009	<ul style="list-style-type: none"> <li>- Lack of top management support</li> <li>- Use of spontaneous volunteers who may not have full training</li> <li>- Low skill levels among field worker</li> <li>- Jobs/tasks are given out without the same degree of oversight that would be present in a non emergency situation</li> <li>- Many organizations have a set way in which they work. Changing this structure can be tough, but also beneficial.</li> <li>- Material required -- not all food aid and other aid are packaged in environmentally friendly materials. So, even if the supply chain is green, there will still be environmental damage being caused after-the-fact with the litter of these materials.</li> <li>- Lack of Green Training, Education &amp; Experience (many still need logistics training and may not have knowledge/training on green methods)</li> <li>- Lack of education and training</li> </ul>



<p>Stakeholder influence on inventory system Lack of co-ordination with other humanitarian organizations</p>		<ul style="list-style-type: none"> <li>- Donor response and public/media reaction</li> <li>- Poor preparedness activities - better logistics capacity assessments would identify opportunities for greening relief supply interventions</li> <li>- Level of coordination between UN/NGOs etc.</li> <li>- Poor inter agency coordination - duplication of effort and therefore excess carbon output and excess waste / environmental impact</li> <li>- Poor donor coordination</li> <li>- Lack of coordination</li> <li>- Lack of attitude and willingness to operate in green way</li> <li>- Performance measurement</li> <li>- Lack of performance measurement systems</li> <li>- Little Time to plan and make decisions.</li> </ul>
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Table 1 shows the grouping and categorization of “informational” and “organizational” barriers. The lack of information inhibits the adoption and implementation of new practices, interestingly enough, the lack of information and communication is also stated as one of the most important features of a non-resilient supply chain (Sheffi, 2005). The statements provided by the experts (see column 3 Relief SC barriers) indicated that there was a low awareness of technologies to reduce carbon outputs; low awareness of green operations; lack of awareness and knowledge how to handle different materials and lack of communication. All these barriers were included under the general category “informational” based on the earlier review of literature. Organizational barriers mentioned by the experts were for example lack of top management support, lack of training and education in green issues, poor coordination and the resistance of organizations to change. In earlier literature these barriers have also been mentioned as resisting forces to introducing new practices and procedures in supply chains. In a similar manner all different statements provided by the experts were categorized. As seen in Table 1, many of the initial barriers (statements) were similar in nature therefore the final step of the analysis involved interpretation of the statements and the forming of more general barriers in line with earlier literature.

In a third round, a table that showed the categorizations, the more general barriers as well as examples of the initial statements was sent out to the experts for review. The experts were told that they could add barriers at this point or also change the categorization of the barriers. However, all experts agreed to the categorization and no further barriers were added in the third round, thereby confirming the initial results of the analysis.

**BARRIERS TO GREENING THE RELIEF SUPPLY CHAIN**

By using literature on resisting forces to adoption of manufacturing and implementation of SC techniques and tools and expert opinions, barriers to greening the relief supply chain were found. Table 2 summarizes the results of this expert round in combination with the findings from the literature review.

**TABLE 2**

<b>General categories</b>	<b><i>Barriers to greening the relief SC</i></b>
<b>Informational</b>	Lack of information Inadequate knowledge
<b>Political</b>	Lack of communication Political limitations
<b>Organizational/Interorganizational</b>	Lack of policies Poor SC partnership management Insufficient training and education Stakeholder influence Lack of coordination Last mile considerations Lack of Top Management Support Poor planning
<b>Temporal</b>	Lack of performance measurement systems Uncertainty of time of event Little time to plan and make decisions. Unpredictable demand Urgency
<b>Technological</b>	Unavailability of appropriate technology Degraded infrastructure Lack of transport infrastructure
<b>Cultural -organizational culture</b>	Goal to help people, environment second at best Lack of attitude and willingness to operate in a green way
<b>Economic</b>	Funding Lack of supplies, equipment Lack of resources
<b>Operational</b>	Inadequate human resources Structures and /or processes not in place

A closer look at Table 2 indicates that the barriers that were found to be relevant for relief supply chains in fact resemble the general barriers found in literature. As no emphasis has yet been put on trying to sort or rank the barriers, no statements on the internal hierarchy of the barriers can be made. If we assume that the amount of statements that could be assigned to a category indicate the importance of this category, clearly the four categories; organizational, technological, cultural and economic, stand out as the most important ones. One of the primary barriers to successful SC collaboration (Fawcett et al., 2008) was human nature due to the fact that people are change averse and prefer to stick to status quo. In our study, this aspect did not stand out, however, further research is needed in order to establish the importance of the noted categories and barriers.

The analysis also shows that even though the general categories fit well with the barriers provided in the relief supply chain setting, some barriers indicated a refinement of the category. For example the category culture in relief supply chains does not only relate to organizational culture as e.g. in the study by deVries (2007). Culture is defined both in terms of organizational culture as well as in terms of the local culture in a country where disaster has struck. Cultural issues play an important role when supplies are chosen for the beneficiaries, for example food items are very culturally bound and are usually specified according to the receiving country preferences. Another important distinction in the barriers is the “temporal” barrier. The temporal barrier indicates an urgency of the disaster response, which is typical for relief supply

chains. In business supply chains, urgency is usually not the determining factor and does not override environmental matters. However, in relief supply chains, the need to save lives in the immediate aftermaths of a disaster usually overrides other issues. The unpredictability that relief supply chains operate in is also included in the “temporal” category. Since the immediacy and temporal factors are a major difference separating relief supply chains from business supply chains, (Balcik & Beamon, 2008), this category may also turn out to be one of the most important ones.

In summary, our initial analysis indicates that there are general barriers to greening the relief supply chain that resemble those barriers found in earlier SC literature. The main differences to for-profit supply chains arise from the context that these supply chains operate in where unpredictability, uncertainty and even security play an important role. In this context, other issues than environmental issues play an important role, maybe the most important role, as lives are at stake. In order to overcome such barriers, planning becomes even more important, that is if we preplan, saving lives might not come at the expense of the environment. However, what is needed is a more thorough review and additional research on the importance of the barriers to be able to address them.

## **CONCLUDING DISCUSSION**

The global demand for humanitarian assistance, which is already considerable, is likely to grow in the coming decade, and to see a major increase in our lifetimes. The biggest single cause will be climate change and the increased incidence and severity of extreme weather events associated with it. Indeed, we are beginning to feel the effects. What we are already witnessing is not an aberration but rather a ‘curtain raiser’ on the future. These events are what I call the ‘new normal’. The number of recorded disasters has doubled from approximately 200 to over 400 per year over the past two decades. Nine of out every 10 disasters are now climate-related. Last year, my office at the UN issued an unprecedented 15 funding appeals for sudden natural disasters, five more than the previous annual record. 14 of them were climate-related. Holmes, 2008, p.4

This citation from the Under-Secretary-General for Humanitarian Affairs and Emergency Relief Coordinator underlines the severity of climate change impact on humanitarian assistance. Humanitarian assistance is expected to grow substantially due to climate change. Logistics costs in relief supply chains are substantial, and thereby the field of relief supply chain management will also increase in importance. The need to introduce green supply chain principles and practices in the relief supply chain is evident, however, no studies have so far addressed the greening of the relief supply chain, a void that this chapter is starting to fill. This chapter aims to explore barriers to implementation of green SC practices in the relief SC. Expert interviews and literature from the fields of humanitarian logistics and green supply chain management are used to establish a list of barriers and to propose a categorization of the barriers. The barriers that were found in this study revealed that earlier literature on barriers or resistance to change in supply chains well describe the barriers that exist in the relief supply chain. However, similar to the differences that exist between business logistics and humanitarian logistics, some barriers are specific to this field, unpredictability and urgency standing out as the most important ones. Nevertheless, this chapter is only a first step in an investigation of barriers that exist when seeking to green the relief supply chain. More research is needed in order to validate the results and in order to rank the barriers in order of importance. Interpretative structural modeling (ISM) is proposed as the next step to integrate expert opinion and help structure the relationships amongst the barriers. Once this structure is understood, prioritization and addressing the barriers becomes clearer. By doing so, the most important barriers can be addressed and future studies can focus on how to overcome the barriers and hopefully aid in greening the relief supply chains.

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