

# Ecosystem Services and the Automotive Sector

## NISSAN MOTOR CO., LTD.

Corporate Planning Department  
Global Environmental Planning Office  
1-1, Takashima 1-chome, Nishi-ku, Yokohama-shi,  
Kanagawa 220-8686, Japan



**UNITED NATIONS  
UNIVERSITY**

**UNU-IAS**  
Institute of Advanced Studies

**NISSAN**

# Contents

## Ecosystem Services and the Automotive Sector

The Impact of Automobiles on Ecosystems and Biodiversity .....	3
<b>1. Biodiversity and Ecosystem Services .....</b>	<b>5</b>
<b>2. New Window: A Review of Ecosystem Services for the Automotive Sector .....</b>	<b>8</b>
2.1 The Corporate Ecosystem Services Review .....	9
2.2 Linking Ecosystem Services and Businesses .....	11
2.3 Nissan's ESR for the Automotive Sector .....	12
<b>3. Assessment of Priority Operations .....</b>	<b>17</b>
<b>3.1 Energy Sourcing .....</b>	<b>17</b>
<b>3.2 Mineral and Material Sourcing .....</b>	<b>20</b>
<b>3.3 Water Usage .....</b>	<b>23</b>
<b>4. Ecosystem Services and the Automotive Sector .....</b>	<b>25</b>
<b>4.1 Energy .....</b>	<b>25</b>
<b>4.2 Mineral and Material Sourcing .....</b>	<b>26</b>
<b>4.3 Water Resources .....</b>	<b>27</b>
Disclaimer .....	29



## The Impact of Automobiles on Ecosystems and Biodiversity

Our lives depend on the natural environment. The ecosystem provides great blessings for humankind by supplying food and freshwater and offering many “services,” such as regulating the climate and offering protection from natural disasters. Humans, on the other hand, use energy and water resources and pollute the air, water, and soil, which have adversely affected the ecosystem and biodiversity. The Millennium Ecosystem Assessment carried out between 2001 and 2005 with support from the United Nations points out that the world’s ecosystems have declined more rapidly and extensively over the past 50 years than at any other comparable time in human history. Maintaining healthy ecosystems and biodiversity is an environmental issue of crucial importance alongside mitigating climate change.

Since 2007 Nissan has been conducting joint research with the United Nations University Institute of Advanced Studies on the impact automobiles have on the ecosystem and biodiversity. Assessments of such impact and benefits received from ecosystem services have been made utilizing the guidelines in the Corporate Ecosystem Services Review (ESR), developed at the same time as the Millennium Ecosystem Assessment. Nissan identified the priority areas it should address as an automaker and considered the best approaches.

The ESR is a structured methodology to help businesses develop strategies by supporting companies understand their dependence and impact on ecosystems. The ESR methodology consists of five steps: (1) select the scope, (2) identify priority ecosystem services, (3) analyze trends in priority services, (4) identify business risks and opportunities, and (5) develop strategies.

The value chain for an automaker encompasses a broad range of activities, from the securing of material resources to the production, distribution, and operation of vehicles; energy consumption; servicing; recycling of end-of-life vehicles; and office-related tasks (communication, foods, use of water, etc.). The current study targets 10 areas ranging from upstream to downstream activities and reviews how they are related to major ecosystem services to assess their level of importance. Over 20 ecosystem services were analyzed and studied, as a result of which the most important for an automaker were identified as being energy, material resources, and water resources.

Automobiles depend almost entirely on oil for energy. The consumption of oil has been linked to climate change through the emission of greenhouse gases and to the degradation of the ecosystem through the drilling of oil wells and contamination of water and soil during transport. Such impact may be reduced through either improvements in energy efficiency or a shift to such alternatives as biofuel, renewable electricity, and hydrogen. While biofuel is an important option, it must be produced through sustainable methods that consider the impact on water and the soil. Renewable electricity may emerge as a realistic choice, as it has little impact on climate change and on ecosystem services.

The securing of material resources is accompanied by the excavation of surface soil and the large-scale logging of forestland. The construction of roads, ports, and other infrastructure can also damage the ecosystem. It will be important to give thought to the impact on the ecosystem when selecting the necessary materials

for vehicle production and to reduce the use of virgin materials through reuse and recycling.

Water resources are also emerging as a critical issue. Regional water shortages and water contamination are impacting agricultural production and the ecosystem. And there have been some cases of industrial uses of water affecting people’s drinking water, leading to criticism from local communities. Global water stress is likely to rise in the future due to population growth, economic development, and climate change. In localities with high water risk, automotive plants, too, should implement water recycling and purification measures.

Nissan is advancing concrete measures in various fields in recognition of the impact automobiles have on the ecosystem and biodiversity. We have improved the energy efficiency of engines to reduce oil consumption, marketed biofuel vehicles, and developed fuel cell vehicles. And in 2010 we launched the Nissan LEAF, a 100% (or ‘fully’) electric vehicle, in the Japanese and US markets; the Leaf will be sold worldwide from 2012. We have already achieved a 95% effective recycling rate in Japan for the resources contained in end-of-life vehicles and are working toward the ultimate goal of 100% globally. We have conducted water risk surveys in our factories around the world, and we are aiming for zero wastewater discharges through the use of reverse osmosis filtration systems. We will continue to ascertain the impact automobiles have on the ecosystem and biodiversity from a broad perspective and address this issue on a global basis going forward.

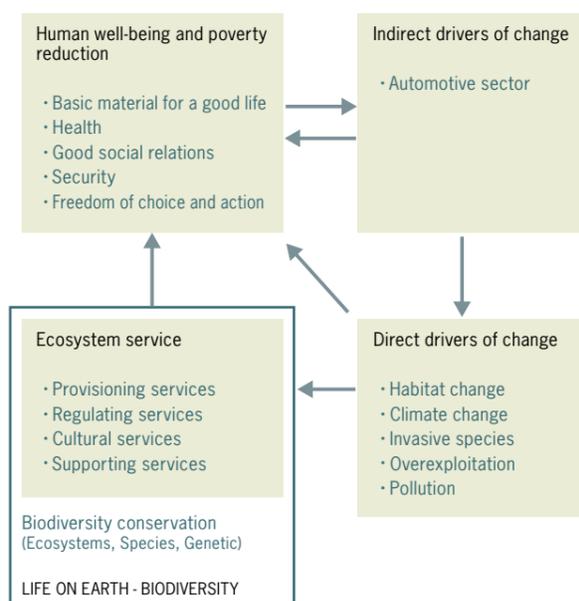
# 1. BIODIVERSITY AND ECOSYSTEM SERVICES

## Introduction

The Earth's freshwater, born as rain and snow on mountaintops, the trees making up a rich, dense forest, the climate that stabilizes natural hazards like floods and fires, all the species that make up biodiversity, and the refreshing, peaceful calm provided by nature—these are all blessings of the ecosystem that sustains and enhances human lives. Changes in the ecosystem can influence the way we live, from access to basic materials to health, good social relations, security, and the freedom of choice and action.

In 2005 the Millennium Ecosystem Assessment (MA) organized by United Nations represented current state of ecosystem services that are provided by nature in its healthy state and the future outlook. The MA indicated a lot of considerable evidences in that our economic activities are heavily dependent upon and greatly influence ecosystem services. This report provides a quick sketch of the relationship between ecosystem services and the automotive sector, based on the MA's conceptual framework of interaction between biodiversity, ecosystem services, human well-being, and human-induced drivers of change.

**Figure 1. Interaction between Biodiversity, Ecosystem Services, and the Automotive Sector**

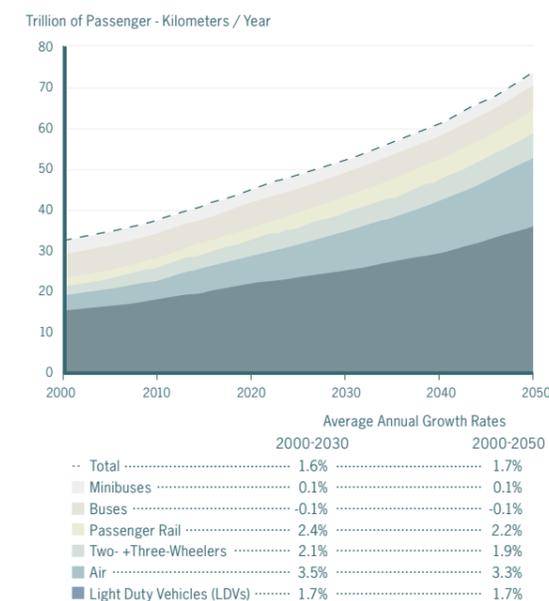


Source: Compiled by Nissan based on the Millennium Ecosystem Assessment, 2005.

## Biodiversity and Ecosystem Services

Economic growth creates demand for transport services. According to the Sustainable Mobility Project, which was conducted by the World Business Council for Sustainable Development, personal transport activities are projected to increase significantly over the next several decades, and land transport, such as light-duty and two-wheel vehicles, is expected to play a key role in meeting our mobility needs. In addition, the project indicated that the transport-related impact on the ecosystem was a significant way to measure the sustainability of our mobility.

**Figure 2. Personal Transport Activity by Mode**



Source: World Business Council for Sustainable Development, Mobility 2030: Meeting the Challenges to Sustainability, 2004.

In terms of global environmental issues, the climate change debate has dominated the environmental discussion for decades, but increasing attention is being drawn to protecting and investing in biodiversity and the ecosystem. The Millennium Ecosystem Assessment provided a state-of-the-art scientific appraisal of the conditions and trends in the world's ecosystems and the services they provide. The assessment was a four-year study to connect ecosystem services, human well-being, and business development involving more than 1,360 scientists, economists, business professionals, and other experts from 95 countries. The assessment discovered that ecosystems have declined more rapidly and extensively over the past 50 years than at any other time in history. Contributing to the decline have been the conversion of forests to cropland, increased use of nitrogen fertilizers, contamination of waterways, water

withdrawals from rivers and lakes, decline of coral reefs that buffer coastlines from storms and static hauls of wild marine fish due to over-harvesting. The assessment projected further declines in the coming decades, especially with the economic growth of developing countries, population growth, and global climate change.

Automobiles impact ecosystems through their production, use, repair, and recycling, and at the same time depend on ecosystems. Ecosystems provide businesses and people with a wide range of goods and services. In the automotive sector, among others, ecosystems provide freshwater to source biofuels and the hydrogen for fuel cell vehicles, mineral resources for production, and climate regulation through the absorption of carbon dioxide. Conversely, the sector has affected ecosystems' regulation of natural hazards through the hydrocarbon extraction of fossil fuels. The benefits from nature are known as "ecosystem services." Biodiversity, or the variability among living organisms within and between species, is also important in this regard as it underpins the supply of ecosystem services. The depletion of fundamental resources in our environment is a concern for us all, for without healthy and replenished ecosystems, biodiversity is endangered and so are businesses that depend on it. Ecosystem degradation is relevant and important for businesses for its direct impact on ecosystems and their dependency of the services ecosystems provide. There is increasingly larger impact on ecosystem services, and while we are still benefiting from them now, their future is in jeopardy.

The MA defined four ecosystem service categories: (1) provisioning services, or goods and products obtained from ecosystems, such as food, freshwater, timber, and fiber; (2) regulating services, or benefits from the ecosystem's natural regulating processes involving climate, disease, soil erosion, water flows, and pollination, as well as protection from natural hazards; (3) cultural services, or the spiritual and aesthetic enjoyment derived from nature; and (4) supporting services, or such natural processes as nutrient cycling and primary production that maintains other services. Table 1 is a list of ecosystem services as defined by the World Resources Institute, based on the Millennium Ecosystem Assessment.

Meeting the bottom line can no longer be the single objective for businesses. Most do not recognize the business opportunities that emerge from risk, and most

focus on environmental impacts rather than dependence. Businesses, in fact, are well positioned to pursue new business opportunities, reduce their ecological footprint, develop and deploy new technology, and lead policy reform to raise environmental standards and competition.

**Table 1. Definitions of Ecosystem Services**

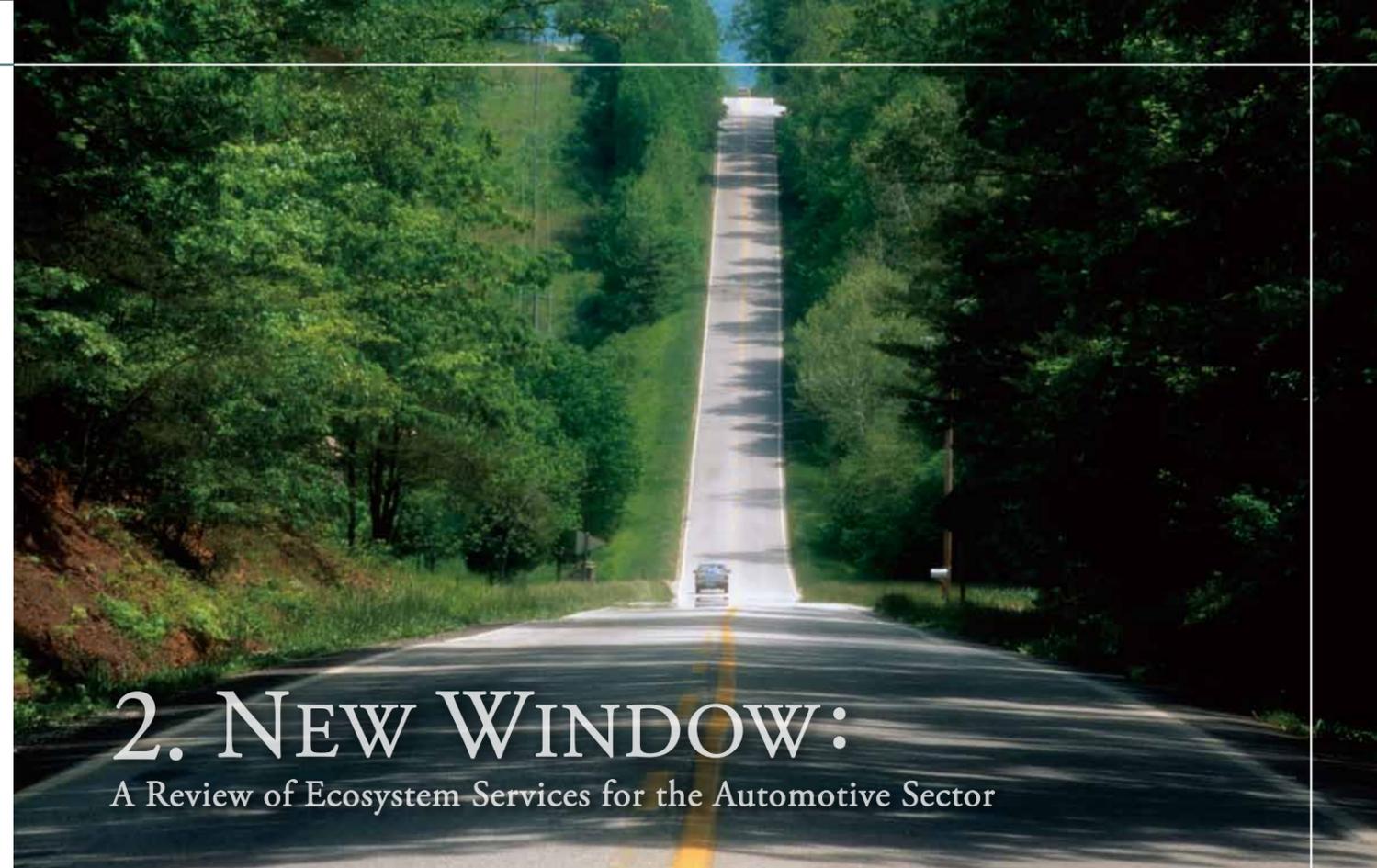
Service	
Provisioning services	Food
	Fiber
	Biomass fuel
	Freshwater
	Genetic resources
	Biochemicals, natural medicines, and pharmaceuticals
Regulating services	Air quality regulation
	Climate regulation
	Water regulation
	Erosion regulation
	Water purification and waste treatment
	Disease regulation
	Pest regulation
	Pollination
	Natural hazard regulation
Cultural services	Recreation and ecotourism
	Ethical values
Supporting services	Nutrient cycling
	Primary production
	Water cycling

Source: Adapted by the World Resources Institute from the reports of the Millennium Ecosystem Assessment, 2005.

## Aim of the Initiative

The Millennium Ecosystem Assessment was innovative in that it brought business and the environment together, linking institutions that deal with the development and the protection of the environment. Traditionally, businesses have focused on the negative aspects of environmental issues, such as regulation, damage to brand image, increased input costs, increased vulnerability to environmental change, and conflict and corruption resulting from scarcity of ecosystem services. However, there are also market and product opportunities for businesses by incorporating ecosystem services into their strategic planning to enhance their corporate image and meet future sustainability challenges.

The aim of this collaborative research is threefold. Firstly, it evaluates the automotive sector's activities and performance with regard to ecosystem services, rather than focusing on standard issues, such as carbon emissions. Secondly, it assesses the automotive sector's dependency on ecosystem services and impacts of its products on the environment based on the Corporate Ecosystem Services Review (ESR) framework and methodology. Lastly, it serves as a strategic planning tool for corporations to become better stewards of the environment through analysis of its opportunities and threats. This innovative and pioneering joint study systematically links the automotive industry and the environment together for sustainable mobility for today's and future generations.



## 2. NEW WINDOW: A Review of Ecosystem Services for the Automotive Sector

Corporations around the world are increasingly recognizing that sustainability—that is, the full composite of long-term social, economic, and environmental factors and considerations—is integral to business strategy. The business environment is rapidly changing as we confront the limits of our global ecosystem. At the same time, there are widening social expectations that multinational businesses solve or at least address some of the most pressing global problems, such as climate change, biodiversity loss, and poverty. As public interest in the environment and sustainability grows, there is increasing pressure to mainstream sustainability into long-term policy and strategy perspectives at the society level and into lifestyle and consumer choices at the individual level. This is prompting more and more corporations, including in the mobility sector, to integrate sustainability as a core concern in their business models. These corporations are taking a long-term systemic approach in examining the direct and indirect impacts of their operations and products, as well as tackling the challenging task of understanding how these factors interact with one another.

To build a society with sustainable mobility, there is a need to rethink the role of mobility and even to change our lifestyles. To begin understanding the diverse impacts and achieve the perceptual and eventually operational

shift, we need to look at the mobility sector through the lens of ecosystem services—that is, we need to go beyond simply looking at where the mobility sector has made strides to achieve environmental friendliness and to go deeper and critically analyze and understand how the mobility sector depends on and in turn influences global, regional, and local ecosystem services. To do so, we employed the Corporate Ecosystem Services Review (ESR) methodology, as detailed below.

## 2.1 The Corporate Ecosystem Services Review

The Corporate Ecosystem Services Review (ESR), developed by the World Resources Institute with support from the World Business Council for Sustainable Development and the Meridian Institute, provides corporate managers with a proactive approach to making the connections between ecosystem change and their business goals. Ecosystems provide businesses with numerous benefits or ecosystem services. However, human activities are degrading these and other ecosystems. Left unchecked, this degradation could jeopardize the future economic well-being of humans and businesses.

The Millennium Ecosystem Assessment (MA) shed light on the importance of ecosystem services for human well-being and business development. This four-year international audit of ecosystems—which involved more than 1,360 scientists, economists, business professionals, and other experts from 95 countries—provided the first state-of-the-art scientific evaluation of the conditions and trends in the world’s ecosystems and the services they provide, as well as the scientific basis for action to conserve and use them sustainably. The categories of ecosystem services are:

- Provisioning services: Goods or products obtained from ecosystems, such as food, freshwater, timber, and fiber.
- Regulating services: Benefits obtained from an ecosystem’s control of natural processes, such as climate, disease, soil erosion, water flows, and pollination, as well as protection from natural hazards. “Regulating” in this sense is a natural phenomenon.
- Cultural services: Nonmaterial benefits obtained from ecosystems, such as recreation, spiritual values, and aesthetic enjoyment.
- Supporting services: Natural processes, such as nutrient cycling and primary production that maintain the other services.

### Key Terms:<sup>1</sup>

- An **ecosystem** is a dynamic complex of plant, animal, and micro-organism communities and their nonliving environment interacting as a functional unit.
- **Ecosystem services**, also called environmental services or ecological services, are the benefits people obtain from ecosystems. They include freshwater, timber, climate regulation, protection from natural hazards, erosion control, and recreation.
- **Minerals and fossil fuels**, such as coal, oil, and natural gas, are natural resources but not ecosystem services. The quantity and quality of minerals and fossil fuels are not dependent upon the living components of existing ecosystems, and there are no benefits derived from ecosystem services, although fossil fuels and some minerals come from organic matter that was alive millions of years ago.
- **Freshwater** is an ecosystem service as the quantity and quality is often dependent upon living components of ecosystems. Forests affect the quantity and quality of freshwater in a region by soaking up water through tree roots, releasing water vapor through leaves, and preventing siltation of rivers.
- **Biodiversity** is the variability among living organisms within species, between species, and between ecosystems. Biodiversity is not in itself an ecosystem service **but rather it underpins the supply of ecosystem services.**

<sup>1</sup> From the World Resources Institute, The Corporate Ecosystem Services Review: Guidelines for Identifying Business Risks and Opportunities Arising from Ecosystem Change.

Although buffered against ecosystem change by culture and technology, all people and businesses fundamentally depend on the flow of diverse ecosystem services that sustain our lives on Earth. The MA found that 60% of the ecosystem services evaluated were degraded over the past 50 years. Humans have changed the Earth’s ecosystems more rapidly and extensively than in any comparable period of time in history, largely to meet our rapidly growing demands for food, freshwater, timber, fiber, and fuel. Some of these examples are the conversion of land to cropland, increased usage of nitrogen fertilizers, contamination of waterways, water withdrawals from rivers and lakes, decline of coral reefs that buffer coastlines from storms, and static hauls of wild marine fish due to over-harvesting.

The MA clearly recognizes that the changes that have been made to our ecosystems have contributed to substantial net gains in human well-being and economic development but also points out that these gains have been achieved at growing costs in the form of the degradation of many life-sustaining ecosystem services and that the current approach, over the long term, is not sustainable or feasible. The MA projected further degradation of ecosystems and the services they provide, particularly as the global population swells to 9.2 billion, emerging economies increase per capita consumption levels, and climate change unfolds. It also warned that further ecosystem deterioration increases the risk that some services, such as freshwater supply, natural hazard regulation, and wild foods, may cross a threshold after which they abruptly and possibly irreversibly decline.

## 2.2 Linking Ecosystem Services and Businesses

These trends matter to companies because the global degradation of ecosystems and the services they provide threaten to alter the landscape in which business operates. Businesses impact ecosystems through consumption, pollution, land conversion, and other activities. Businesses also depend on services provided by ecosystems, sometimes free of charge. Companies often fail to make the connection between the health of the ecosystems and the business bottom line, not fully aware of the extent of their dependence and impact on ecosystems and the possible ramifications.

The ESR is designed to help businesses explicitly make this link and to inform corporate strategy. It is designed for use by a wide range of business sectors and is particularly relevant to the automotive industry for its supplier and customer direct interaction with the ecosystem. At its most formal, the ESR is a structured methodology to help businesses develop strategies to help companies understand their dependence and impact on ecosystems and the resulting business risks and opportunities in a coherent, systematic manner. Many other tools are more suited to handle traditional issues of pollution and natural resource consumption, though most focus on environmental impacts rather than dependence, and on risks rather than business opportunities that emerge from the risks.

The ESR is a unique assessment tool that can complement and strengthen other environmental approaches and assessments by:

- Evaluating corporate activities with regard to the emerging issue of **ecosystem services** rather than more standard issues, such as corporate emissions and effluents.
- Assessing **all** major ecosystem services.
- Assessing a company's impact **and** dependence on ecosystem services, not just its impact.
- Evaluating a company vis-à-vis the environment **and** what people value in the environment.
- Forming **corporate strategy** with information about business risks and opportunities.

However, the ESR does not identify or address every environmental issue: it does not provide an exhaustive inventory list or quantification of a company's total environmental footprint, greenhouse gas emissions, water effluents, or other emissions released into the

environment. The ESR does not take a company's mineral or energy consumption trends but rather addresses a **subset of priority** environmental issues, namely, those arising from a company's dependence and impact on ecosystem services. Moreover, the ESR does not rely on quantitative information or economic valuation, as quantitative information on ecosystem services is often sparse or nonexistent; rather it successfully utilizes qualitative analyses to identify potential business risks and opportunities. The ESR is easily adaptable to examine various depths, depending on the chosen scope, availability of data, and amount of staff involved.

### Key ESR Concepts

- A company **depends** on an ecosystem service if that service functions as an input or if it enables, enhances, or influences environmental conditions required for successful corporate performance.
- A company **impacts** an ecosystem service if the company affects the quantity or quality of the service.
- A company's **priority ecosystem services** are those services on which the company has a high dependence and/or impact and thereby are the most likely sources of business risk or opportunity to the company.
- **Drivers** are factors, natural or man-made, that cause changes in an ecosystem and its ability to supply ecosystem services.

## 2.3 Nissan's ESR for the Automotive Sector

Though perhaps not immediately obvious, mobility—whether private transport for convenient mobility and personal freedom or public and commercial transport of goods for a robust economy—is in fact dependent on and impacts services provided by ecosystems. In the automotive sector, the ecosystem provides freshwater to source biofuels and the hydrogen for fuel cell vehicles, mineral resources for production, and climate regulation through the absorption of carbon dioxide. It also impacts the regulation of natural hazards through the extraction of hydrocarbons in fossil fuels. This presents operational, regulatory, reputational, market and product risks to the industry.

Nissan, in rethinking its green strategy, conducted a Corporate Ecosystem Services Review to explore factors that contribute to sustainable mobility and the relationship between and interactions among ecosystem services and the automotive sector. Through a “rapid assessment” by leading experts and key Nissan managers and later an extensive “desktop analysis,” the ESR identified priority areas for Nissan to consider as a stepping stone to developing its next environmental strategy with the concept of ecosystem services at its core.

### Rapid Assessment

To conduct the ESR, Nissan and the United Nations University Institute of Advanced Studies (UNU-IAS) organized an expert workshop in Palo Alto, California, in August 2008 consisting of a brainstorming session to jointly develop preliminary perspectives on the relevant ecosystem services and a rapid assessment session to prioritize subsequent analyses.

The ESR methodology consisted of five steps: selecting the scope, identifying priority ecosystem services, analyzing trends in priority services, identifying business risks and opportunities, and developing strategies. Various stakeholders with perspectives relevant to every stage of the ESR were brought together, including Nissan executive managers to ensure strategic buy-in and implementation of the ESR results, managers from respective business units, and external experts and UNU-IAS consultants to provide perspectives and conduct ESR-related analyses.

World-renowned MA experts and analysts in the area of biodiversity and ecosystem services, including Professor Harold A. Mooney of Stanford University, Janet Ranganathan of the World Resources Institute, Charles Perrings of Arizona State University, and Christopher Field of Stanford University, offered detailed information on the conditions and trends of ecosystem services. Presentations by Nissan provided internal information sources for those outside the company to fill knowledge gaps. The rapid assessment session was an opportunity to react to each other's perspectives and subsequently prioritize ecosystem services with direct implications for the automotive sector, which were further analyzed as a desktop study.

### Step 1 Scope of the Nissan ESR

The scope of the Nissan ESR covered 10 areas of the value chain, including upstream and downstream aspects of business operations. The implications of ecosystem service trends for key suppliers were highlighted in the upstream analysis, while the downstream study sought insights into the implications of ecosystem service trends for Nissan's customers. The upstream segment specifically looked at mineral mining, fossil fuel sourcing, biofuel sourcing, and materials sourcing of metals and chemicals. Under company operations, the study looked at manufacturing, logistics, and Nissan's office usage; and the downstream review included customer use of Nissan automobiles, road construction and maintenance, and the recycling, disposal, and exports of scrapped cars.

The Nissan ESR did not look at specific business units, product lines, facilities or natural assets owned, or any specific suppliers but rather took a more abstract approach using a holistic framework in considering ecosystem services in the automotive sector. Moreover, there was no geographic focus. While this broad scope posed challenges in data gathering and analysis management, it stimulated creative discussions and enabled ecosystem service sketching at workshops to generate priorities. Afterward, the assessment was refined, filling in the gaps and resolving differences in perspectives for a focused, extensive desktop analysis.

**Table 2. The Value Chain Used for the Nissan ESR**

Upstream:Suppliers	Nissan Operations	Downstream:Customers
<ul style="list-style-type: none"> <li>Mineral mining</li> <li>Materials sourcing (metals, chemicals)</li> <li>Parts production</li> <li>Logistics</li> </ul>	<ul style="list-style-type: none"> <li>Manufacturing (fabrication, painting, thin-coating, assembly)</li> <li>Logistics (ground and ocean transportation)</li> <li>Office usage</li> <li>Sales</li> </ul>	<ul style="list-style-type: none"> <li>Customer use (driving)</li> <li>Fuel consumption</li> <li>Road construction and maintenance</li> <li>Recycling, disposal, and exports of scrapped cars</li> </ul>

Source: Compiled based on WBCSD, Meridian Institute, WRI, The Corporate Ecosystem Service Review, 2008.

**Step 2 Identifying Priority Ecosystem Services**

This step was a screening exercise to evaluate, in a structured yet rapid manner, the company’s dependence and impact on more than 20 ecosystem services to help identify priority services. Priority services are

most likely to be sources of risk or opportunity for the company; put more simply, they are the ones that the company most depends upon or most highly impacts. These became the focus of analysis in subsequent steps. If the company is dependent on a particular ecosystem service, the company faces business risks, such as higher input costs or disruption to its operations. If a company impacts an ecosystem service—either negatively by depleting or degrading it or positively by supplying or enhancing it—this has reputational and regulatory implications for the company.

For this step, there is a need for a company to understand its dependence and impact on each ecosystem service. To identify its priority services, Nissan managers and experts conducted a rapid assessment to determine the level of dependence and impact on each ecosystem

**Table 3. Ecosystem Services Dependence and Impact Matrix**

Ecosystem Services	Upstream : Suppliers		Nissan Operations		Downstream : Customers		
	Dependence	Impact	Dependence	Impact	Dependence	Impact	
Provisioning	Food	●					
	Fiber		●				
	Biomass fuel		●			●	
	Freshwater	●	●	●	●	●	●
	Genetic resources		●				
	Biochemicals, natural medicines and pharmaceuticals		●				
Regulating	Air quality regulation		●		●	●	
	Climate regulation		●		●	●	
	Water regulation		●				
	Erosion regulation		●			●	
	Water purification and waste treatment	●	●		●	●	●
	Disease regulation		●				●
	Pest regulation		●				●
	Pollination		●				
	Natural hazard regulation				●		●
	Cultural	Recreation and Ecotourism		●		●	●
Ethical values			●		●	●	
Supporting	Nutrient cycling		●				
	Primary production						
Water cycling							

Source: Compiled based on WBCSD, Meridian Institute, WRI, The Corporate Ecosystem Service Review, 2008.

service. Participants were asked to rate the dependence and impact and provide accompanying comments and reasoning for their ratings in the following dependence and impact matrix adapted for Nissan.

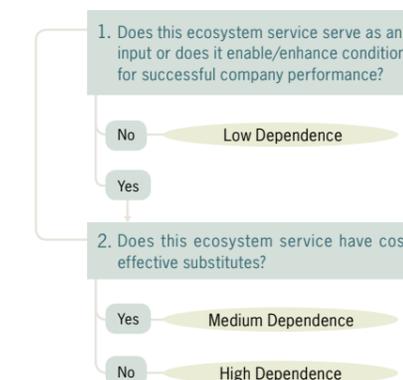
Though qualitative and quick, the ESR questionnaire enables managers and experts to conduct a dependence and impact assessment in a structured manner using just five questions and enhances the likelihood of uncovering overlooked dependencies and impacts.

**Evaluating Dependence**

To evaluate whether Nissan was dependent on an ecosystem service and by how much, two questions were asked for each ecosystem service. The first was, “Does this ecosystem service serve as an input or does it enable/enhance conditions for successful company performance?” If the ecosystem service is not an input or does not enhance or influence environmental conditions required for successful corporate performance, the company has a low dependence on that service. If the answer to the first question was yes, a second question was asked: “Does this ecosystem service have cost-effective substitutes?” The extent to which the company is dependent depends on whether the service has a cost-effective substitute. If there is such a substitute, the company has medium dependence; if there is no substitute, the company is highly dependent on that service.

Answering yes to the first question and no to the second question indicates that the company’s dependence upon the ecosystem service is high. Answering yes to both questions indicates medium dependence. Answering no to the first question indicates low or no dependence on the ecosystem service.

**Figure 3. Questions for Evaluating Dependence**



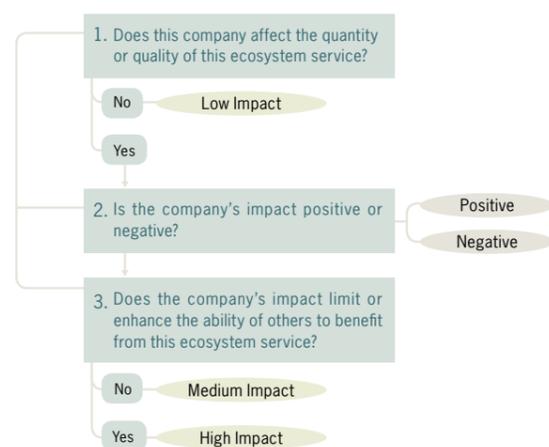
Source: Compiled based on WBCSD, Meridian Institute, WRI, The Corporate Ecosystem Service Review, 2008.

**Evaluating Impact**

To determine whether Nissan impacts an ecosystem service and by how much, three questions were asked. The first was: “Does the company affect the quantity or quality of this ecosystem service?” If the company does not affect the quantity or quality of that ecosystem service, Nissan has a low impact on that service. If yes, a second question was asked to determine the extent of the impact: “Is the company’s impact positive or negative?” The impact is positive if the company increases the quantity or quality of the ecosystem service; negative if it decreases the quantity or quality. Further, for items whose answer was yes to the first question, a third question was asked: “Does the company’s impact limit or enhance the ability of others to benefit from this ecosystem service?” The extent to which the company impacts an ecosystem service is determined based on whether it limits or enhances the ability of others to benefit from that service. This also determines whether the company faces a business risk or opportunity. If the company does not limit or enhance the ability of others to benefit, it has a medium impact; if it does limit or enhance, the company has a high impact on that service.

Answering yes to the first and third questions indicates the company’s impact on the ecosystem service is high. Answering yes to the first question and no to the third question indicates medium impact. Answering no to the first question indicates that the company’s impact is low or negligible.

**Figure 4. Questions for Evaluating Impact**



Source: Compiled based on WBCSD, Meridian Institute, WRI, The Corporate Ecosystem Service Review, 2008.

### Priority Ecosystem Services

Fifteen participants, including Nissan managers, MA experts, and UNU-IAS researchers, each completed a dependence and impact assessment for 10 value chain areas to identify priority ecosystem services. Each assessment matrix was tallied to create a dependence and impact summary matrix. An ecosystem service received a score if 5 out of 15 respondents identified a particular ecosystem service to have a high, medium, or low dependency or positive/negative impact. For example, freshwater received a “high impact” score when 5 or more persons assessed that the automotive sector negatively impacts freshwater service to source biofuels. The assessments were tallied to create a summary matrix.

In accordance with the ESR guideline, top-tier services—that is, those that scored high in categories of both dependence and impact—were identified to have the most priority. Second-tier services were those high in one category and medium in the other. And third-tier services were those high in one category and low in the other. Negative impacts were prioritized over positive. Those with low scores in both categories were not considered priority services.

Based on this assessment, the following seven ecosystem services were selected as priorities for consideration for Nissan and the broader automotive sector:

- **Freshwater**

All 10 areas examined in the assessment noted freshwater as a priority. From “well to wheel,” or oil extraction to vehicle operation, the automotive sector significantly depends upon access to water. This can have a negative impact on the quantity of freshwater by depleting this valuable and finite resource.

- **Air quality regulation**

The automotive sector strongly impacts air quality regulation along the entire value chain, from fossil fuel sourcing to manufacturing, logistics, and finally customer automobile use.

- **Climate regulation**

Greenhouse gases and aerosols emitted into the atmosphere largely through fossil fuels, biofuels, and material sourcing, as well as through company operations and customer automobile use, all potentially influence the global climate. (Biofuel production is dependent on climatic and weather conditions and in part also absorbs greenhouse gases and aerosols).

- **Water regulation**

Mineral mining and fossil fuel sourcing impact the water storage potential in an ecosystem or landscape. Biofuel production farms depend on their surrounding ecosystems to regulate water runoff, control floods, and recharge aquifers.

- **Erosion regulation**

Fossil fuel, biofuel, and material sourcing and mineral mining all significantly negatively impact vegetation and soil retention. Customer automobile use and road construction indirectly impact erosion regulation, as vegetation covers are cleared for infrastructure development.

- **Water purification and treatment**

The automotive sector is highly dependent on freshwater and thus naturally dependent on the ability of ecosystems to filter and decompose organic wastes and pollutants in water.

- **Natural hazard regulation**

The ability to regulate natural hazards can be highly impacted by society’s infrastructure development choices. For example, filling in coastal wetlands to develop scenic ocean-view roads may make the area

and those depending on this infrastructure vulnerable to coastal hazards. Fossil fuel and mineral extraction, often in very difficult terrains, opens up the possibility of numerous man-made environmental risks and could undermine nature’s ability to mitigate climatic change, leading to increases in regional rainfall or absence of expected rain in other areas.

Though not explicitly mentioned in these seven ecosystem services, changes in ecosystems have an impact on the biodiversity inherent in these ecosystems.

To understand the full implications of these seven priority ecosystem services for the mobility sector, the next section expands on them, focusing specifically on the following three business areas:

- (1) Energy sourcing
- (2) Mineral and material sourcing
- (3) Water usage

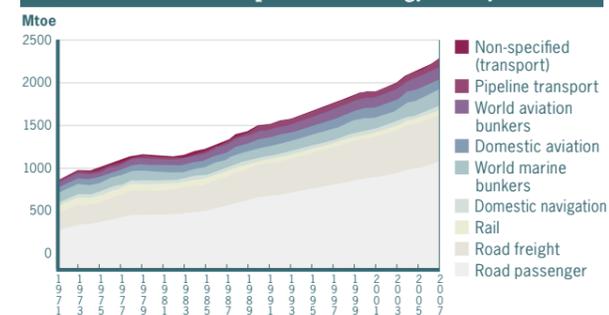
# ASSESSMENT OF PRIORITY OPERATIONS

## 3-1. ENERGY SOURCING

The three priority business operations, as ascertained from data research and discussions among experts during the Corporate Ecosystem Services Review, were energy sourcing, mineral and material sourcing, and water usage. These were evaluated for both dependence and impact on ecosystem services.

The world's consumption of primary energy is 12 gigatons per year (oil equivalent), with the transport sector using about 20% of this total. Within the sector, road traffic accounts for 70%, half of which is consumed by automobiles running primarily on petroleum and other fossil fuels. The mass consumption of petroleum raises concerns about its impact on the ecosystem through the emission of greenhouse

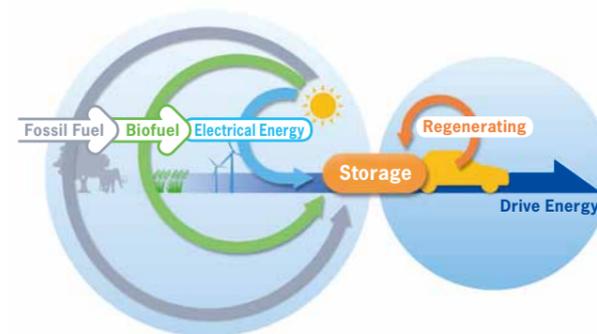
Figure 5. World Transport Final Energy Use by Mode



Source: IEA, Energy Technology Perspectives, 2010 (France).

gases, which many scientists believe cause climate change, and the contamination of the soil and water in excavating and transporting oil. Ways to check this impact include enhancing energy efficiency and shifting to non-fossil-fuel alternatives, such as biofuel, hydrogen, and electricity.

Figure 6. Shifting from Fossil Fuels to Renewable Energy Sources



### 3.1.1 Fossil Fuels

The mass consumption of petroleum resources impacts the ecosystem through the emission of greenhouse gases, which many scientists believe cause climate change. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change warns that rising global average temperatures will have a grave impact on the ecosystem. A rise of more than 1 degree Celsius could potentially increase the bleaching and death

of corals and the risk of extinction for 30% of all species. And a rise of more than 4 degrees could potentially lead to the extinction of a substantial number of species.

Also of concern is the impact on the natural environment made by the excavation of oil. If the excavation and shipping of oil are not properly managed or if adequate thought to the environment is not given, oil spills could contaminate the soil and water, which could have a major impact on agriculture and fishing. Given the leveling off of oil production from existing wells, efforts are being made to develop new sources of fossil fuels, such as oil sands and deep-sea reserves. But the excavation of such new sources has the potential for greater impact on the environment than existing ones, and this could have an adverse impact on the ecosystem. Extracting petroleum from oil sands requires a large volume of natural gas. Producing one barrel of petroleum requires the excavation of two tons of oil sands, so the impact on the soil and water resources would be large. The drilling of deep-sea wells requires highly sophisticated technology, and there is always the risk of oil spills. The accident in the Gulf of Mexico in April 2010 resulted in large volumes of oil spilling into the deep sea, raising fears of serious damage to oceanic ecosystems, such as along the coast and deep-sea areas of the gulf.

In order to reduce the potential impact of petroleum and other fossil fuels on the ecosystem, it is important to improve the energy efficiency of automobiles so they consume less such fuels and to shift to such alternatives as biofuel, hydrogen, and electricity.

### 3.1.2 Biofuel

Biofuel is in liquid form and is easy to handle. It does not require major changes to existing automobiles and can be used fairly easily as an alternative to fossil fuels; it is a promising energy source that already meets about 1% of automotive energy needs. Bioethanol made from corn and sugar cane accounts for 90% of biofuels, while biodiesel made from rapeseed and sunflower makes up the remaining 10%. The US, European, and many other governments have indicated they intend to expand the use of biofuels in the future as a way of reducing carbon dioxide emissions and ensuring energy security.

The manufacture of biofuels is intimately linked with many ecosystem services, so greater elucidation of their impact and dependence on the ecosystem will be required. One impact is the emission of greenhouse gases during the

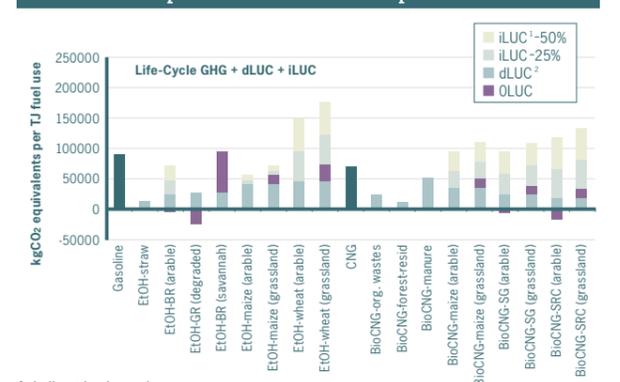
production process. Others include the impact on water resources and the soil as well as on biodiversity hotspots like tropical rainforests and mangroves.

Greenhouse gas emissions in biofuel production tend to be lower when using agricultural residues and cellulose-based biomass—such as perennial weeds and bushes—than when made from corn and other crops. Biofuel can significantly raise emissions when carbon is extracted from the soil; this results either from direct changes in land use, such as when new land is cleared for cultivation, or from indirect factors, such as when different crops are grown, leading to soil erosion and outflows and the utilization of different fields.

Biodiesel produced from oil palms grown in fields that were once tropical rainforest leads to far greater emissions of greenhouse gases than that grown on already eroded soil. Generally speaking, tropical rainforests, savannas, and other ecosystems rich in biodiversity are thought capable of storing more carbon in the soil. By giving greater thought to changes in land use, it may be possible to prevent biodiversity loss and ecosystem degradation. In the automotive sector as well, when selecting biofuels that reduce greenhouse gas emissions, greater thought should be given to not only the ingredients used but also the kind of land on which the biomaterials are grown.

Another important consideration is the impact of biofuel production on water resources and the soil. With regard to the latter, soil degradation occurs with the use of fertilizers or herbicides when growing the plants used to make the fuel. There is 10 times more soil degradation when growing corn and soybeans than perennial weeds and bushes. Research is being conducted on plants that can be grown with reduced fertilizer volumes; cellulose-based biomass is preferable in this regard because it can help avoid soil erosion.

Figure 7. Comparison of Environmental Impact of Various Biofuels



1. Indirect land use change  
2. Direct land use change

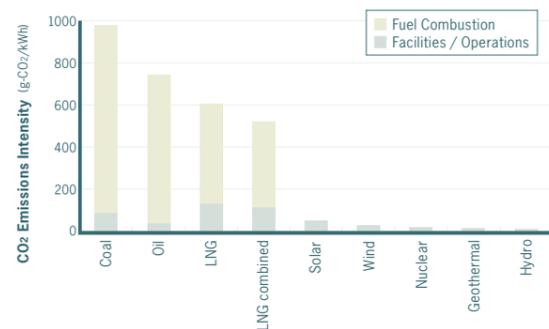
Source: Uwe R. Fritsche, Bioenergy GHG Emission Balances including Direct and Indirect Land Use Change Effects (Darmstadt: Oeko-Institute e.V., 2009).

While there is no question that biofuels represent an important option in shifting to renewable energy sources, they must be produced in ways that are sustainable. At the same time, assessment indices should also be developed to enable judgments of the sustainability of each type of biofuel. If the use of biofuels is to be expanded in advancing an energy shift, the automotive sector should promote those biofuels that are considered sustainable.

### 3.1.3 Electricity and Hydrogen

Electricity is a strong option as an automobile energy source that can help cut oil consumption. Fossil fuels account for 68% of electricity generation around the world, with petroleum accounting for 6%. Electric vehicles have higher energy efficiency than either gasoline or diesel vehicles, so they can help reduce reliance on fossil fuels and petroleum. If the use of fossil fuels in electricity generation can be significantly reduced, such as by expanding solar and wind power generation, then impact on global warming can be further reduced. Electricity has little impact on water and the soil, so it has great potential to reduce the automotive impact on the ecosystem.

Figure 8. Comparison of CO<sub>2</sub> Emissions by Energy Source



Source: Report of the Central Research Institute of Electric Power Industry, etc.

Figure 8 shows levels of CO<sub>2</sub> emissions by energy source. The burning of fossil fuels like coal, oil, and natural gas emits 500 to 900 grams of CO<sub>2</sub> per 1 kWh of energy generated. Solar and wind generation and other renewable energy sources, on the other hand, emit far less CO<sub>2</sub>—under 50 grams—even when emissions during the manufacture of equipment are included. Table 4 reveals that the water footprint during power generation varies greatly depending on the type of carrier. Biomass and

stored water hydropower have large footprints, while solar and wind power have relatively small footprints and are regarded as having a small ecosystem impact.

Table 4. Water Footprint of Energy Carriers

Primary energy carriers		Global average water footprint (m <sup>3</sup> /GJ)
Non-renewable	Natural gas	0.11
	Coal	0.16
	Crude oil	1.06
	Uranium	0.09
Renewable	Wind energy	0.00
	Solar thermal energy	0.27
	Hydropower	22
	Biomass energy	70 (range:10-250)

Source: Water Footprint Network, 2009.

The use of electric vehicles and further reliance on renewable energy sources will be important ways of reducing the ecosystem impact of automobile energy sources. Power generation methods cannot be changed by the automotive sector alone, however, and there is a need to cooperate with the electric power industry and the government.

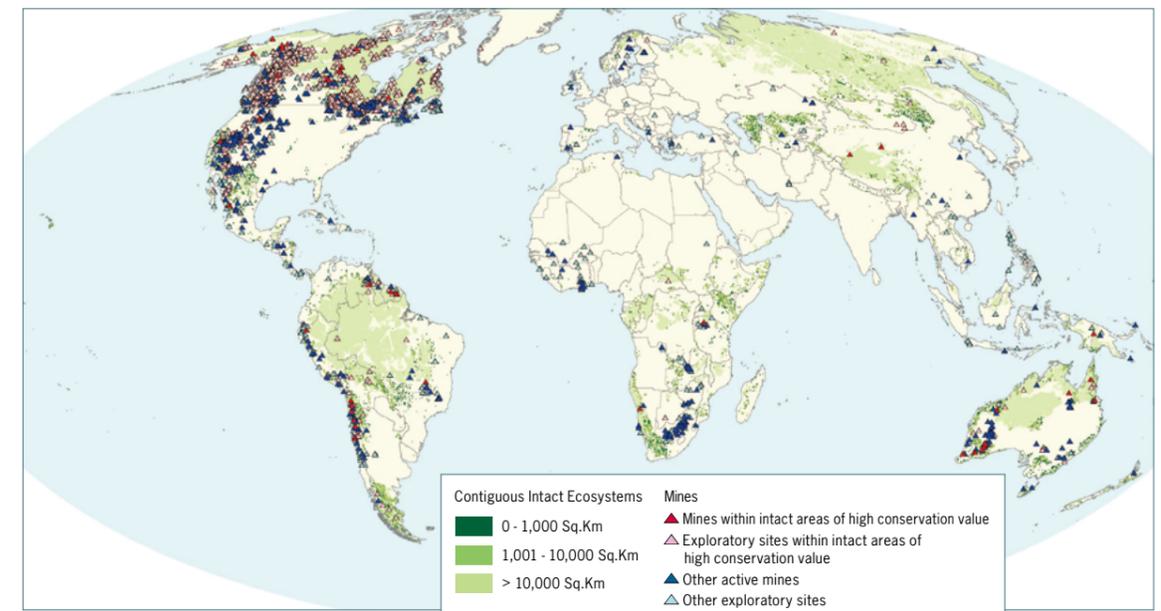
Hydrogen, meanwhile, is also considered a promising clean energy source for automobiles. There will be no significant reductions in greenhouse gas emissions, however, depending on the methods used to manufacture hydrogen, such as modification of fossil fuels like natural gas. But if, like electricity, renewable sources are used to create hydrogen, there is the potential of lessening impact on global warming and the ecosystem. The costs of manufacturing and transporting hydrogen are comparatively higher than gasoline, so breakthrough technologies will need to be developed to bring these costs down.

## 3-2. MINERAL AND MATERIAL SOURCING

The development of mineral resources may involve stripping away the topsoil or cutting down forests on a large scale. There are also times when it is necessary to construct roads, harbors, or other infrastructure, which may result in the loss, damage,

or division of ecosystems in some cases. According to the World Resources Institute, 10% of the mines now operating and 20% of the mines being explored are located in areas classified as having ecosystems that are worth preserving.

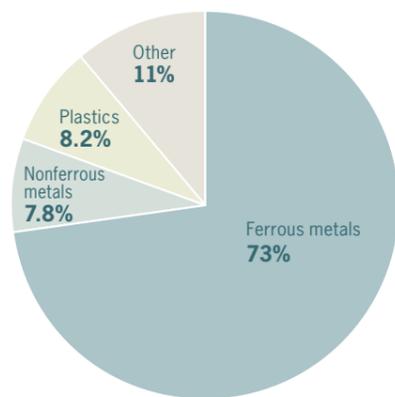
Figure 9. Intact High Conservation Value Areas



Sources: Dinerstein et al., 1995; Sanderson et al., 2002; CI, 2001; Bryant et al., 1997; Strattersfield et al., 1998. Last of the Wild Data Version 0, 2002. Wildlife Conservation Society (WCS) and Center for International Earth Science Information Network (CIESIN). Note: Degree of human influence is over estimated on the island of New Guinea. Mining Data ©1994-2003 InfoMine Inc. All Rights Reserved.

Metals account for approximately 80% by weight of the materials used to build a vehicle, making automobiles highly dependent on mineral resources (Figure 10). The impact of the extraction of mineral resources on various ecosystems is one risk factor for the automotive sector in the procurement of necessary resources. Therefore, efforts by the automotive sector to conserve resources with resource saving design and to promote recycling are important in reducing the quantities of virgin mineral resources needed. Equally important are efforts at the time of procurement to select resources having minimal impact on ecosystems.

Figure 10. Material Composition of a Vehicle



Source: the Japan Automobile Manufacturers Association, Inc., 2001.

### Impact of Mining Minerals on Ecosystem Services

The development of a mine requires enormous quantities of water, and large amounts of wastewater are returned to the watershed. Consequently, it is imperative to exercise thoughtful and deliberate water management in order to avoid damaging ecosystem services, such as water provision and water purification and treatment.

In addition, at the mine operation stage, there is the risk that the water quality or soil around a mineral extraction site might be contaminated by waste rock dumps or tailings. For example, while annual production of copper ore is 15.35 million tons, it has been reported that this results in a greater total amount of around 25.6 billion ton of mineral wastes. To prevent contamination, discharges and waste must be properly managed to avoid any impact on the resilience of ecosystems.

Table 5. Global Ecological Rucksacks

Materials moved to secure mineral resources (2002)				
		A	B	A/B
Gold mines	239 mines	2,249 tons (ore)	Materials moved 3.06 billion tons	$7.35 \times 10^{-7}$
Copper mines	331 mines	15.35 million tons (ore)	Materials moved 25.6 billion tons	$5.9 \times 10^{-4}$
Iron ore		900 million tons (iron and steel)	Materials moved 4.8 billion tons	0.19
Coal mines		3.84 billion tons (coal)	Materials moved 23.0 billion tons	0.17

Source: Compiled based on Masatsugu Taniguchi's "Kokueki to chikyueki o kangaeta shigensenryaku o" (A Resources Strategy That Considers Both National and Earth Interests), Global Net, September 2006.

### Conservation and Recycling of Resources

Reducing the consumption of virgin materials through the conservation and recycling of resources should be considered among the first approaches for minimizing the impact on ecosystems caused by the use of mineral resources. Various advanced initiatives can be seen in Japan in this regard.

With regard to the conservation of resources, designs that give consideration to the 3R concept of "reduce, reuse, and recycle" are being introduced into every facet of the vehicle life cycle. This initiative is based on a vision of minimizing the consumption of newly extracted resources by maximizing the recycling of end-of-life vehicles (ELVs) into reusable resources. One example of the conservation of resources through waste reduction and recycling activities is the reuse of parts recovered from ELVs, which is being promoted in addition to previous efforts to downsize and lighten the weight of vehicles. Systems have been put in place that use the dealership networks affiliated with the automotive sector for the sale of parts and vehicles to support an integrated flow of recycling operations from the removal of parts from ELVs to their sale to consumers. These systems are not simply reselling parts removed from ELVs. They are also engaged in remanufacturing functional parts and parts for which safety is a critical requirement, such as the engine, alternator, transmission, and others. This involves disassembling the parts, cleaning them, and confirming their performance before they are sold as remanufactured parts.

Efforts to promote the recycling of resources can be seen in various material recycling activities. For example, automobile manufacturers themselves recover aluminum wheels from ELVs, recycle the material, and use it to make parts that require high quality, such as suspension parts,

among others. Further expansion of the market is needed to encourage the reuse of parts, while the development of recycling technologies to maintain high quality is required to promote the recycling of metals. The automotive sector should continue its vigorous efforts to promote these initiatives in cooperation with ELV dismantlers and others. At the same time, the formation of inter-industrial clusters should also be examined from the perspective of expanding the use of recycled materials originating from ELVs.

### Materials Stewardship and Procurement

In May 2003 the International Council on Mining and Metals (ICMM) announced a set of 10 principles as a basic framework for sustainable development activities. Included among these ICMM principles are commitments to "contribute to the conservation of biodiversity and integrated approaches to land use planning" and to "seek continual improvement of our environmental performance." The Minerals Council of Australia (MCA) then announced its Enduring Value program as guidance for industries in implementing the ICMM principles. In their downstream position in the value chain, automobile manufacturers should procure resources with a high degree of transparency under this type of guidance.

The implementation of the materials stewardship advocated by the ICMM has great significance for the preservation of ecosystems. Materials stewardship is defined as "the responsible provision of materials and supervision of material flows towards the creation of maximum societal value and minimum impact on man and the environment." Specifically, this policy encompasses the two aspects of (1) process stewardship, under which the mining sector exercises responsibility from the exploration stage to the raw materials manufacturing stage, and (2) product stewardship, for which the manufacturing industry is responsible from the product manufacturing stage through market introduction to the waste processing stage. The mining sector and the manufacturing industry cooperate with each other in implementing materials stewardship, making it possible to minimize the impact that the use of resources has on ecosystems. It is important for the automotive sector to promote materials stewardship together with the mining sector and to give precedence to the procurement of resources that take into account the minimization of the impact on ecosystems.



## 3-3. WATER USAGE

Reference was made during the August 2008 ESR workshop among experts and Nissan managers to the growing sense of urgency over the automotive sector's impact on water resources. Water usage is growing due to global population growth and economic development, and climate change has resulted in changes in precipitation volumes. These developments are adding to the gravity of water-related issues.

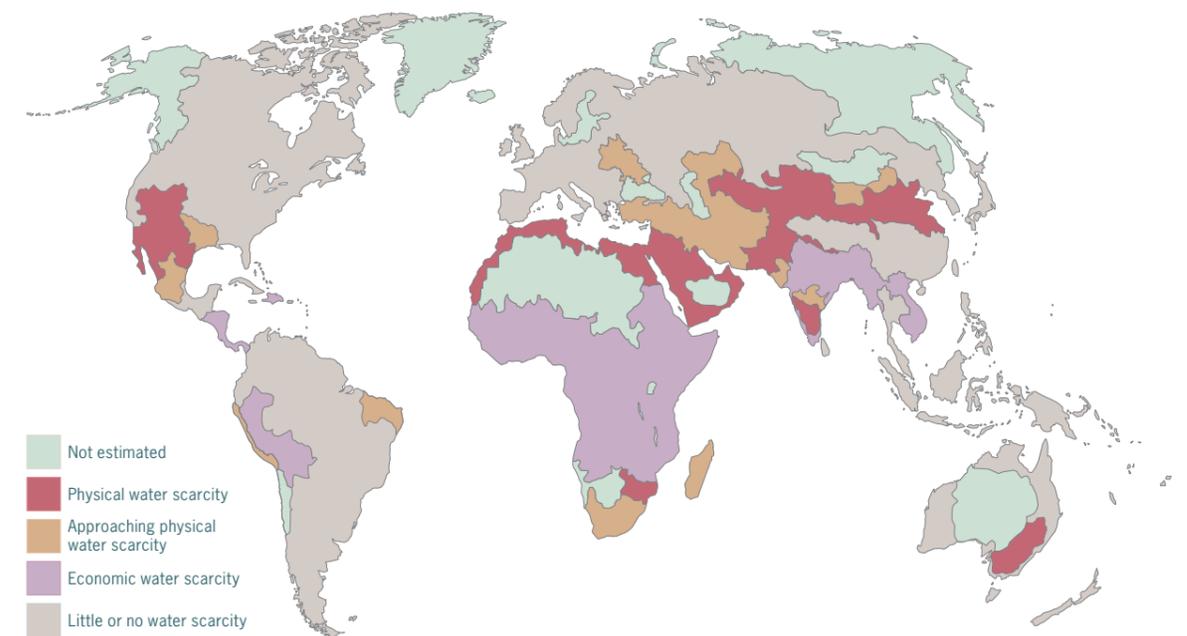
Worldwide water usage increased 2.6-fold in 1995 from 1950 levels, according to the 2000 World Water Vision published by the World Water Council. This is higher than the 2.2-fold increase in the global population. In 1995 approximately 70% of water was withdrawn for irrigation purposes, some 20% by industry, and around 10% by households. It also reported that a fifth of the world's population did not have adequate access to safe drinking water. Water stress is defined as a ratio (critical ratio) of the volume of water withdrawn annually to that which is potentially available or renewable. Water stress is said to be present when the percentage exceeds 10%. Due to the rise in water consumption, some two-thirds of the world's population are expected to live in regions with water stress by 2025. Stress is expected to rise in broad areas of Africa, the Middle East, India, northern China, Australia, and North America, and there is concern that this could affect food production. Excess withdrawals can also have

a damaging impact on the ecosystem. This is not only an urgent matter for UN agencies, funds, and various research organs but also an important issue that industry should become involved in addressing.

The automotive sector should first consider its consumption of water resources during production. Because a plant's impact on water resources will differ according to its location, the issue should be considered on a plant-by-plant basis.

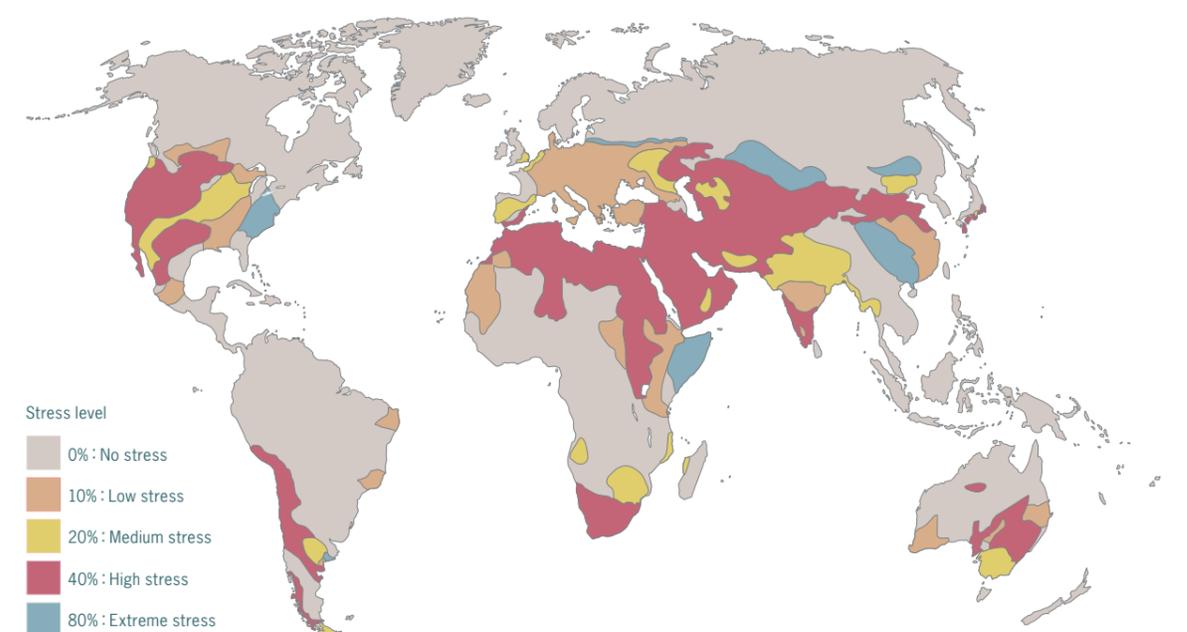
The Nissan ESR revealed that the company was dependent on water throughout the value chain, so greater consideration to water consumption must be given in a wide range of processes.

Figure 11. Areas of Physical and Economic Water Scarcity



Source: Compiled from International Water Management Institute, Areas of Physical and Economic Water Scarcity, 2007.

Figure 12. Water Stress in 2025



Source: Compiled from the World Water Council, World Water Vision: Making Water Everybody's Business, 2000.

# ECOSYSTEM SERVICES AND THE AUTOMOTIVE SECTOR

## 4-1. ENERGY

**How is the automotive sector linked to ecosystem services? Which aspects of the sector's value chain are deeply dependent on such services and which strongly impact on them? An analysis made using the methods of the Corporate Ecosystem Services Review revealed that upstream sectors, such as energy, material resources, and water resources, were important. Nissan's initiatives regarding these segments are outlined here.**

Nissan has been involved in improving the energy efficiency of its gasoline and diesel engines and also in developing and marketing vehicles that run on non-petroleum based alternative energy sources. Examples of the latter include those using biofuel, fuel cell vehicles that run on renewable hydrogen, and electric vehicles. Since 2005 Nissan has been marketing flexible fuel vehicles in the North American market that can run on bioethanol. Research development efforts have also been directed toward the successful development of fuel cell vehicles that perform on a par with gasoline ones. Nissan have begun marketing electric vehicles in Japan and elsewhere in 2010. The technologies contained in these vehicles are expected to play a big role in reducing the consumption of fossil fuels and mitigating the impact of automobiles on ecosystem services and biodiversity.

Electric vehicles not only have a smaller environmental footprint but are also superior to gasoline vehicles in terms of acceleration and quietness. Technological advances in recent years have also improved their overall performance and lowered costs, and they are likely to emerge as next generation cars. Nissan has a long history of making electric vehicles, having marketed its first model in 1947; it began active development of high-performance models in the 1960s, and it has since announced or marketed many experimental and production vehicles. This experience helped Nissan develop a lithium-ion battery with high endurance reliability and performance. The Nissan LEAF, carrying a laminated lithium-ion battery, have launched in Japan and the United States in December 2010 and marketed globally from 2012. Through technological advances and new models, Nissan will further expand its market lineup of electric vehicles.

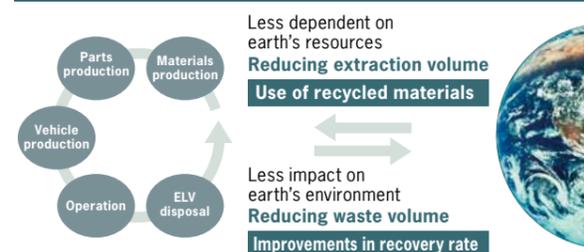
To generate electricity with minimal impact on the environment, there is a need to improve the generating efficiency of thermal electric power and raise the share of electricity produced from renewable sources like solar power. Nissan will actively participate in projects organized by the national and local governments to expand the generation of solar and other sources of renewable power for use in electric vehicles.

## 4-2. MINERAL AND MATERIAL SOURCING

Nissan has placed great importance on recycling activities to reduce the volume of mineral extraction. We have not only introduced designs for new models that facilitate recycling but also taken steps to properly dispose of end-of-life vehicles (ELVs).

The ultimate goal of resource recycling is 100% recovery of ELVs. To move nearer to this goal, Nissan is shifting the focus of its activities to maximize the use of ELV materials. Vehicles are designed so that parts can be removed easily, and those made from materials that can be recycled are dismantled and reused as much as possible as materials in new cars, thus helping to reduce the extraction of nonrenewable resources.

**Figure 13. The Ultimate Goals of Resource Recycling**

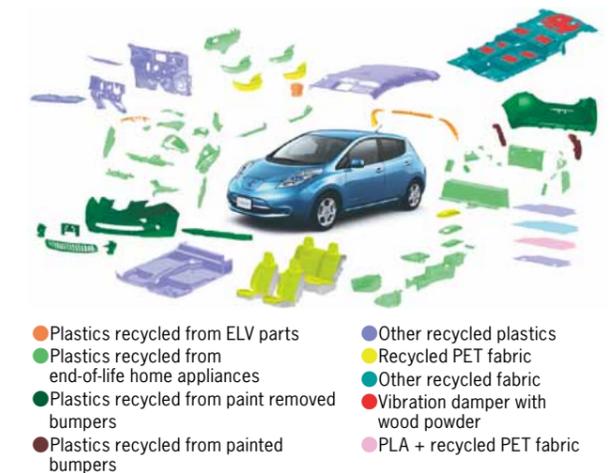


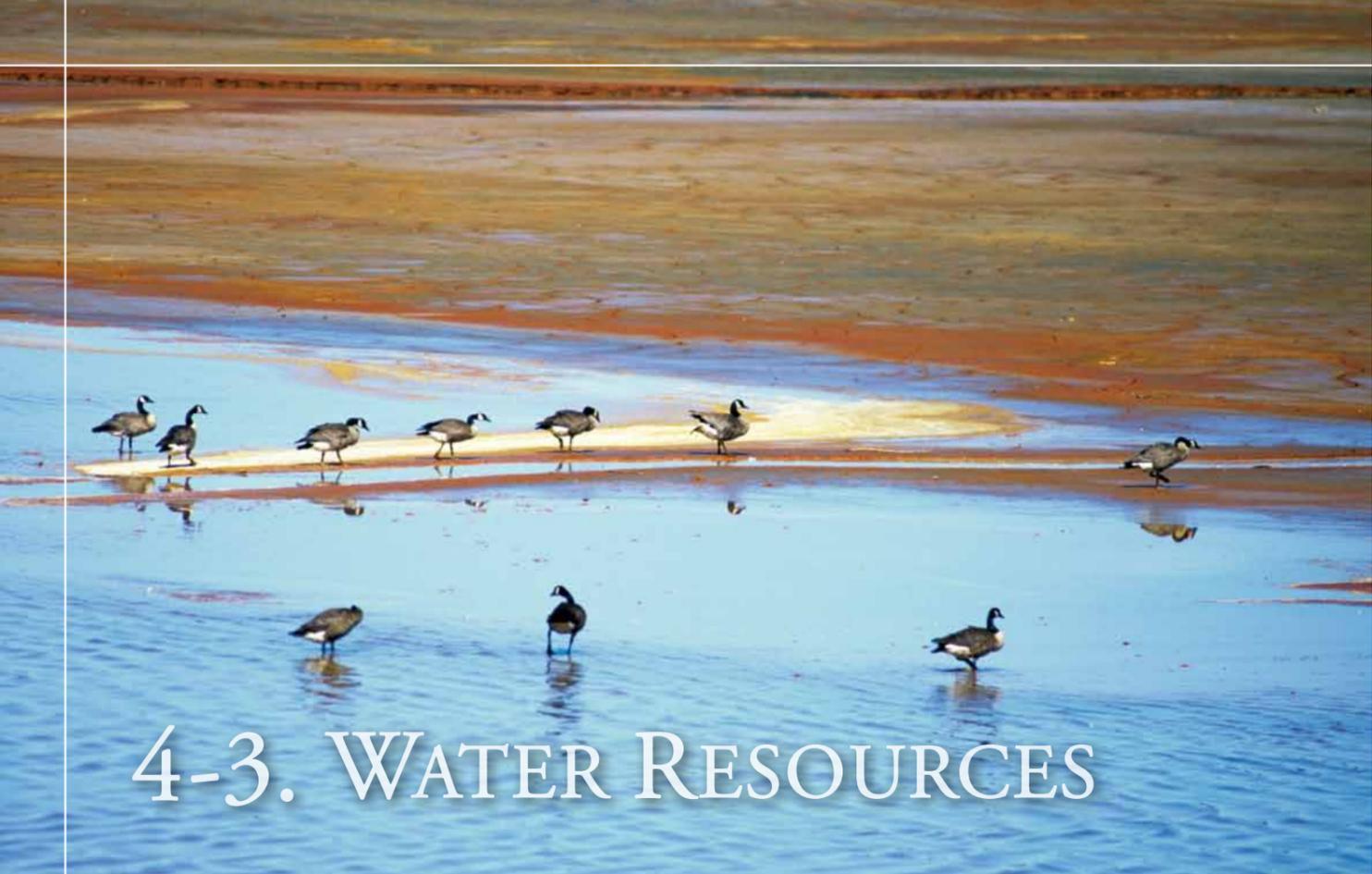
The Nissan LEAF is an electric vehicle that will not emit any CO<sub>2</sub> while running and its impact on the environment during the production of materials and disposal at the end

of life has been minimized as well. It avoids materials not conducive to recycling in its design and utilizes many that have been recovered from end-of-life products. There are also plans for a secondary-use "4R" project to reuse, resell, refabricate, and recycle electric vehicle batteries. Because Nissan's high-performance lithium-ion batteries potentially retain up to 80% of their residual capacity after their use in an electric vehicle they can serve as energy-storage solutions.

These wide-ranging initiatives will lead to significantly reducing the volume of resource extraction and lessening the impact on the ecosystem.

**Figure 14. Recycled Materials Used in Nissan LEAF**





## 4-3. WATER RESOURCES

There are over 40 plants in 18 different countries building Nissan-branded vehicles and parts, and they all use water as part of the production process.

Water-use assessments were carried out at all plants, which were categorized into three levels according to an in-house water risk scoring method, and activities have been pursued that are relevant to the plants' respective circumstances. The highest-risk plants were placed at Level A, defined as a plant that either already has a water related problem or is expected to face one in the near future. Water reduction targets have been independently set for each of these plants, which will undertake activities to reach those targets. Level B plants are those with the potential for water problems; they will regularly monitor water risks, in addition to undertaking the voluntary water-reduction activities they have been pursuing to date. Level C plants are at low water risk, and they will continue their voluntary water-reduction initiatives. These classifications and activity levels have been adopted as uniform, company-wide standards, and the initiatives that had been pursued separately at each plant are now being undertaken throughout the company.

For instance, a plant in India that is likely to be classified at Level A has already launched a water-use reduction program ahead of schedule. Concrete measures

to cut down on water usage are being implemented at the input (water intake), processing (production), and output (discharge) phases. At the input phase, a 40,000 cubic meter reservoir has been built to collect rainwater, which is helping reduce water intake from outside the plant. Measures at the processing phase involves using pure water and a filter to control the quality of the cooling tank water for the body welding machine and compressor; this helps prevent concentration of the coolant so it does not need to be replaced frequently and thus leads to intake reductions. As for the output phase, a reverse osmosis membrane is used at the final stage of wastewater treatment to enable the recycling of wastewater; filtered concentrated water is further distilled and recycled to reduce the intake of water from outside the plant.

Figure 15. Water Risk Scoring

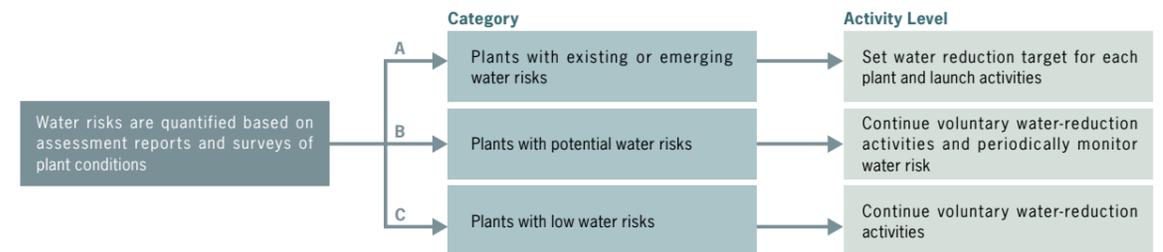


Figure 16. Water Conservation Activities at India Plant



Rainwater reservoir (40,000 m<sup>3</sup>)



Reverse osmosis membrane equipment

### For the Future

**The application of analytical methods to assess the impact of automobiles on ecosystem services and biodiversity; and the implementation of measures to reduce such impact has just begun.**

**Research launched jointly by Nissan and UNU-IAS in 2007 has not only generated many new insights but also provided a broad perspective with which to view the natural environment and the impetus to take new steps toward concrete action. Corporate activities depend upon and also impact ecosystem services and biodiversity in a variety of ways. This joint study has not produced all the answers, but Nissan believes that compiling and broadly communicating its findings will give companies not only in the automotive sector but in different industries around the world an opportunity to reconsider how they should relate to the ecosystem and biodiversity. We hope that this will contribute to the further development of an environmentally sustainable society.**

## Disclaimer

*This report contains the findings of a joint study conducted by the United Nations University Institute of Advanced Studies and Nissan, based on the views of outside experts with specialist knowledge of ecosystem services and biodiversity. Much remains unknown about ecosystem services, however, and this report outlines only what is currently believed to be understood. UNU-IAS and Nissan are not responsible for the execution of the entire contents of this report.*

*Each sections are mainly coordinated by following participant of the study;*

- |  |  |
|--|--|
| <i>1. Biodiversity and Ecosystem Services</i>          | <i>Claudia ten Have</i>                              |
| <i>2. New Window</i>                                   | <i>Claudia ten Have</i>                              |
| <i>3. Assessment of Priority Operations</i>            | <i>Toshio Hirota</i>                                 |
| <i>4. Ecosystem Services and the Automotive Sector</i> | <i>Toshio Hirota<br/>Mayako Nara<br/>Taro Kuroda</i> |

## Authors

**(Organization or company information are at the time of joint research, and may have changed since then.)**

<i>Claudia ten Have</i>	<i>United Nations University Institute of Advanced Studies</i>
<i>W. Bradnee Chambers</i>	<i>United Nations Environment Programme</i>
<i>Hiromi Asahi</i>	
<i>Toshio Hirota</i>	
<i>Taro Kuroda</i>	<i>Nissan Motor Company, Ltd.</i>
<i>Mayako Nara</i>	
<i>Takashi Suminaga</i>	

## Acknowledgements

**(Organization or company information are at the time of joint research, and may have changed since then.)**

The authors wish to express their deep gratitude to the participants of the Nissan ESR workshop for their contributions to the compilation of this report, namely, Harold A. Mooney of Stanford University, Charles Perrings of Arizona State University, Janet Ranganathan and John Finisdore of the World Resources Institute, Marielle C. Weikel of Conservation International, Michael Kleeman of the University of California, and Heather Tallis of the Natural Capital Project.

They also express their deep gratitude to Junko Edahiro of Change Agent and Japan for Sustainability and to Riichiro Oda of Change Agent for their cooperation in the composition and facilitation of the workshop. And also, a deep appreciation to Hidetoshi Tahara for his profound contribution to the comprehensive study coordination and creation of the report.

They are also very grateful to the following individuals for cooperating with this study:

<i>Kana Yamashita</i>	<i>Conservation International</i>
<i>Uwe R. Fritsche</i>	<i>Oeko-Institute e.V.</i>
<i>Clarice Wilson</i>	<i>United Nations Environment Programme</i>