Chapter 19
Socio-Ecological Studies in Urban and Rural Ecosystems in Chile

Olga Barbosa and Paula Villagra

Abstract To embrace a global "Earth Stewardship", researchers associated with the Chilean Long Term Socio-Ecological Research (LTSER-Chile) network, highlighted the urgent need to integrate the variety of ecosystems and cultures, and overcome the bias of information centered in Northern Hemisphere. However this initiative doesn't include the Chilean territory under strongest anthropogenic influence, and where most of the population lives and relies economically: agricultural lands and cities. Here we present two innovative projects contributing to the international Earth Stewardship Initiative: urban planning in the city of Valdivia, and the development of sustainable winery in Mediterranean Chile. Urban concentration amplifies strong social inequities that not only impact individual's economic opportunities, but also the environmental quality of the surrounding landscapes and the ecosystem services they provide. In Chile, a highly urbanized country and prone to natural disasters, access to ecosystem services, provided for example by wetlands and urban forest remnants are essential to mitigate the effects of such catastrophes. Similarly, a conservation initiative with the wine industry was recently developed to preserve the threatened Mediterranean ecosystem, and improve vineyard management practices to minimize impact on native biodiversity and ecosystem services that sustain the wine industry and local communities. For both study cases a complementary approach through capacity building activities with the local community (bottom-up) coupled with building relationships with government institutions and corporations (top-down), have increased the effectiveness of the decision making process, highlighting that an holistic approach to Earth Stewardship should consider a variety of values, and undertake a socio-ecological approach.

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A novel framework for Earth Stewardship as a means of engaging science and society to reduce the rates of anthropogenic damage to the biosphere has been proposed by the Ecological Society of America (ESA) (Power and Chapin 2009; Chapin et al. 2011). In our era of the Anthropocene (Crutzen 2002), the integration of social and ecological dimensions of ecosystems is essential to advance towards Earth stewardship. However, in order to truly embrace "Earth Stewardship" as a planetary phenomenon, researchers associated with the Chilean Long Term Socio-Ecological Research (LTSER-Chile) network have highlighted the urgent need to integrate a wide variety of heterogeneous ecosystems and cultures, and overcome the bias of information centered in Northern Hemisphere sites (Rozzi et al. 2012). To address these needs, the recently created LTSER–Chile has added a new biome (South American Temperate Forests) to the International LTER network, and also has introduced the methodological approach of field environmental philosophy (FEP) (Rozzi et al. 2012). FEP's methodological approach which integrates ecological sciences and environmental ethics into biocultural conservation, thereby contributing to the implementation of Earth stewardship (Aguirre Sala, in this volume [Chap. 15]).

LTSER-Chile is a valuable initiative, however it does not include the Chilean territory under the strongest anthropogenic influence, and where most of the population lives and relies economically: agricultural lands and the cities. The Chilean population is markedly urban (> 87 %, MINVU 2014), concentrated in cities that occupy only 0.23 % Chile's continental land. The Chilean Economy relies on natural resources: mining, fishing and agricultural industries account for approximate 25.8 % GDP (Banco Central 2012). This context raises two major challenges for the Chilean LTSER: to reach the urban population, and to engage the economic sector, both private and public. Private sectors have been incorporated into conservation partnerships worldwide, through approaches such as corporate social responsibility strategies (Tang and Li 2009).[1]

In this chapter we present two innovative projects that can contribute to both the LTSER-Chile network and the international Earth stewardship initiative: urban planning in the city of Valdivia in southern Chile, and the development of sustainable winery in central Chile. Both projects are funded by national scientific research funding agencies, demonstrating an emergent recognition by the Chilean government of the importance of addressing urban ecosystems, and engaging in partnerships with the private sector. We discuss how a socio-ecological approach might essential to advance towards ecosystem stewardship.

[1] The concept of integrating corporate social responsibility into conservation projects, and some specific cases, have raised a strong controversy (see MacDonald 2010).

19.1 The Challenge of Incorporating Stewardship in Chilean Urban Planning

Latin America has experienced one of the fastest growth in urban population since mid-twentieth century (WUP 2011; Rozzi 2013), and cities have sprawled fast into areas of high biodiversity value (Pauchard and Barbosa 2013). According to the ONU-Habitat (2012) report the rates of rural – urban migration are now expected to decrease. In addition, urban concentration amplifies strong social inequities that not only impact individual's economic opportunities, but also the environmental quality of the surrounding landscapes and therefore, the potential ecosystem services that can be beneficial (Pauchard and Barbosa 2013; Rozzi 2013).

Chilean cities rely on ecosystems service provisions in a variety of ways. However, these services are available in a differentiated manner to different socio-economic groups. Urban poor communities are more dependent but have less access to them than wealthy communities, which are also able to substitute these benefits. For example, wealthy neighborhoods may lack public green spaces for recreational use, but they can afford a garden, which acts as partial substitutes for these spaces (Barbosa et al. 2007). Inequality is marked in Chile, and poor communities are more vulnerable to the negative effects of natural disasters. The country is prone to natural disasters such as flooding (e.g. El Niño events), volcanic eruptions and earthquakes, and human-made disasters, such as fires. Natural areas often offer ecosystem services such as food, fuel, and water, which are of particular importance in the event of a catastrophe, and others, such as recreation and beauty, which are relevant in daily life.

Moreover, some approaches to urban planning have resulted in uncontrolled urban sprawl, informal settlements, and negligent location of housing in non-secure areas, causing large infrastructure, economic, and human losses. Recently, during April 2014, more than 2,900 people lost their homes, and 15 lost their lives in the biggest fire ever recorded in Chilean main port city, Valparaiso. The fire, was fueled by nearby extensive tree plantations of exotic fast-growing species (*Eucalyptus sp and Acacia dealbata*), and spread easily due to unplanned territorial development, illegal trash dumps, and the steep geography with fast winds and extremely difficult accessibility. This and other examples have revealed the need to encourage and strengthen socially and -ecologically integrated approaches, and to study risks to human populations and environmental systems from natural disturbances to improve urban planning in South America (LA RED 2013). Complementarily, some sociological studies exploring the key factors that increase the chances of survival of groups under high-risk conditions, have identified community practices that maintain traditional relationships with ecosystems, which are important for mitigating the consequences of natural disasters (e.g. García et al. 2012). However in Chile, this type of integration in policy and research is still missing. While in 1931 the first building code required taking precautions against tsunamis and earthquakes (Art. 178), these indications no longer appear in the 1949 building code, which is still in effect (Herrmann 2014). It was not until, 1974 that the National Emergency Agency

(ONEMI) was created, but with limited powers. Even though the ONEMI includes the perception of risk as important for preventing or mitigating disasters, the agency only is allowed to make recommendation to the local municipalities. Finally it is the municipality that decides the type of intervention applied to the landscape. Today, these models are outdated and differ from international disaster recovery plans and models that highlight the valuable role of ecosystems services (Vale and Campanella 2005; ISDR 2005; Resilience Alliance 2010).

In southern Chile, the fluvial city Valdiva, for example, has a past and recent history of natural disasters where certain ecologically important structures have provided ecosystem services to the population. However, today these places (e.g. urban wetlands and urban forest remnants) hardly are valued by local authorities and thus continually disappear, often being replaced by housing developments. In 1552 when Valdivia was founded as a Spanish fort the city was surrounded by the Valdivia River that had clean and navigable waters, as well as lakes with an abundance of birds, other wildlife, and luxuriant flora as described in historical records (Guarda 2009). Today, several of these Valdivian natural attributes could be considered as cultural ecosystem services due to their beauty, recreational opportunities, and river transport advantages (Guarda 2009). However, this natural urban landscape underwent several changes over time due to virtually continuous processes of reconstruction following natural disasters, housing and infrastructure densification, and constant urban sprawl. By 1885 the lakes mostly had been filled in for housing developments. The need for homes caused by the devastating effects of a 1909 fire led to even more pressure to fill remaining wetland areas. The most dramatic of urban changes in Valdivia occurred after the severe 1960 earthquake, when the South American Plate lurched upward as much as 20 m relative to the subducting Nazca Plate (Barrientos and Ward 2007), adding new wetlands to the already existing ones. Wooden tents used as temporary housing facilities, the *rucos*, were located around these new wetlands (Fig. 19.1a). Over the years, *rucos* were replaced by permanent housing, creating new neighborhoods next to these swampy areas (e.g. Skewes et al. 2012). These changes have formed an urban landscape in which society and nature interact. However, these interactions have not respected these places as sources of water since the 1960s earthquake, nor as sources of city beautification and recreation valued as it was in 1552, when the city was founded. The way that these places have been valued have changed over time, risking their current existence.

A recent study funded by the National Commission for Technology and Scientific Research (CONICYT) revealed some of the social values associated with the wetlands during the aftermath of an earthquake in Valdivia (Villagra et al. 2014). Wetlands were found to be amongst the seven most used urban spaces for earthquake recovery. Nonetheless, their utility varies depending on the presence or absence of a set of biophysical aspects that modify their appearance, and hence, their utilitarian values. In case of an earthquake scenario nowadays, the study shows that the presence of biophysical attributes such as water, vegetation, street infrastructure, and iconic architecture in the urban landscape, cause them to be perceived as useful for shelter, evacuation, and temporary housing. Studies in two other coastal

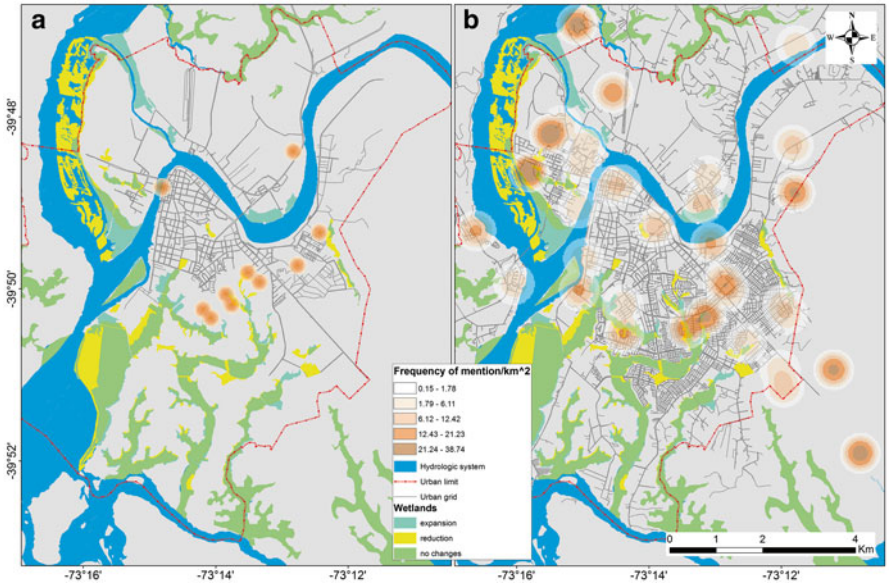

Fig. 19.1 The figure shows land use change in the city of Valdivia close to, and in wetland areas. Panel (**a**) shows Valdivia main city configuration in 1961, 1 year after the 9.5 earthquake, where areas close to wetlands were used as temporal housing (the 'rucos') which evolved later into permanent housing. Panel (**b**), shows that similar areas close to wetland would be used for the allocation of trash and debris in a hypothetical post-earthquake scenario today and the evolution of main urban wetlands

cities, San Francisco and Kobe, have proved that in the presence of water and vegetation found in urban parks and streams, were fundamental for earthquake recovery after the 1909 and 1995 earthquakes respectively (Allan and Bryant 2011; Hayashi 2010). However, in Valdivia, most wetland areas are perceived as places to dispose debris and garbage, regardless of the water and vegetation these places contain, a situation that can be witnessed every day (Fig. 19.1b).

Landscapes perceived as dirty, unmanaged, and dangerous, or even just empty, tend to be valued negatively by planners and urban dwellers (Van den Berg et al. 2007). This is the case for Valdivia where wetlands were once a 'beautiful' landscape useful for sailing and recreation (Guarda 2009), but now are waste lands with overgrown vegetation, lack of public urban infrastructure, and accessibility. Interestingly, a similar study in Concepcion, Chile, proved the opposite situation than in Valdivia. This study found urban wetlands useful for water extraction, temporary refuge, as places for public gathering, rather than for debris and waste disposal (Villagra and Rojas 2013). In Concepcion, the wetlands provide daily recreation and have been taken into account for urban design, intervention, and management, as they were perceived as positive assets by the community following an earthquake scenario. The little value assigned to urban wetlands in Valdivia today, as providers of ecosystems services after a disaster, is probably due to their

negative appearance resulting from mismanagement over the last 50 years. However, urban planners and designers should take into consideration the dynamic nature of urban landscape values, which can change from their usual recreational use to a depository for waste and debris. Today, educational initiatives lead by local civic organizations, such as taking school children to 'discover' wetland areas, are aimed at changing community values and attitudes toward wetlands by direct exposure to these important habitats. Nevertheless, the impact of these initiatives need to be monitored by long-term perception studies, in line with the LTSER- Chile strategy.

19.2 Working with the Wine Industry Towards Earth Stewardship

Mediterranean Ecosystems, characterized by mild winters that concentrate rainy-season and warm dry summers, are areas of great, but highly fragile, ecological value (Myers et al. 2000; Olson and Dinerstein 2008). They host high diversity and endemism rates of floras that exceed the combined rates of tropical Africa and Asia (Arroyo and Cavieres 1991; Cowling et al. 1996). Geographically they include portions of USA, Mexico, Chile, Australia, and South Africa, as well as the Mediterranean Basin, and tend to be densely populated regions. The Chilean Mediterranean Region extends between 23 and 39.5° South, and although it represents only 16 % of the country's territory, it harbors almost 50 % of Chilean vascular plants, including 50 % of endemic species (Arroyo et al. 1995; Armesto et al. 2007a, b).

Mediterranean areas around the globe historically have exhibited an intense anthropogenic pressure due to agricultural and urban land uses, and globally have less than 4.5 % under any conservation protection category (Cox and Underwood 2011). Chile is not an exception, with 77 % of the population (INE 2011) and 76 % of the country's GDP (Banco Central 2012), concentrated in its Mediterranean region. Despite its ecological value and the threats to its biological integrity, less than 1 % of the regional surface is under any official protection (Underwood et al. 2009). This has proven to be insufficient for biodiversity conservation (Simonetti 1999; Tognelli et al. 2008; Durán et al. 2013). Two centuries of intensive deforestation, together with intensive grazing by cattle and extremely variable rainfall, have had long-lasting effects on forest cover in south-central Chile, whose effects are persistent even today (Armesto et al. 2010). In addition, economic incentives to forestry in the last two decades, together with economic globalization and free trade, promoted the expansion of new crops, leading to the further decline of woodlands. One of these new crops are grapes for wine production.

The wine industry has expanded persistently in the Chilean Mediterranean region with 63,550 hectares (ha) in 1997 to 128,367 in 2012 (202 % growth), and recently expanding beyond the Mediterranean limits (MINAGRI 2013, Fig. 19.2a). The image of Chile is very much associated with the wine industry. Most vineyards own

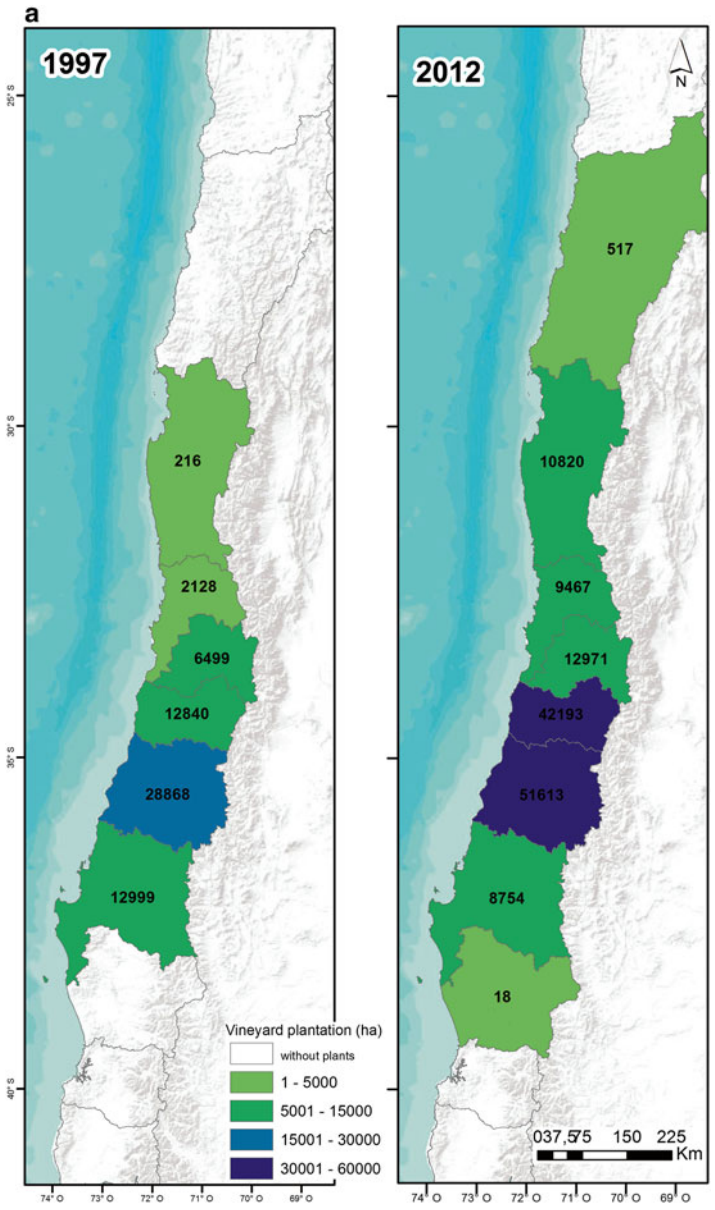

Fig. 19.2 (**a**) Evolution of vineyard expansion by administrative region between 1997 and 2012, in the Mediterranean zone of Chile

Fig. 19.2 (**b**) Photo of Viña Veramonte, with native forest remnants in the background in Casablanca valley, a main wine production valley (Photo Olga Barbosa)

between 2 and 4,000 ha, or more, of natural adjacent land. Moreover, the quality of the wine is defined by its geographic origin, a meaning that is captured in the French term "*terroir*" (Viers et al. 2013). This term highlight the connection between the resulting product (e.g. wine) and the environment (Wilson 2001; Renouf et al. 2006), thus inclining the industry to favor the conservation of Mediterranean ecosystems (Fig. 19.2b).

With the opportunity afforded by innovative new funding by the government of Chile (Fondos BASALES, CONICYT), a group of Chilean scientists embraced a 5-year program working with the wine industry to develop ways to balance the growth of the industry and the conservation of this highly fragile ecosystem. This program was planned essentially through research on the links between the provision of ecosystem services to vineyards, and their susceptibility under climate change and land use change, leading to the establishment of the Wine Biodiversity and Climate Change Program (WBCC).[2] The overall goal is to improve vineyard design with management practices that minimize their impact on native biodiversity and ecosystem services that sustain the wine industry and local communities.

Since the beginning of this program, the number of wineries interested in partnering with the WBCC consistently has increased, from one in 2008 to 14 in the first 5 years of the program, together accounting for nearly 70 % of wine Chilean global exports by volume (Wines of Chile 2013). However, after 2 years of developing

[2]The Wine, Climate Change and Biodiversity Program is a scientific initiative of the Institute of Ecology and Biodiversity and Universidad Austral de Chile, which aims to conciliate biodiversity conservation with the development of the Chilean wine industry. www.vccb.cl

basic research, it was realized that deliveries in both time and spatial scale were not really coupled with the producers' immediate needs. This was especially evident when the world financial crisis hit at the beginning of 2008, when many producers expressed the willingness to continue the ongoing collaboration, but needed to postpone any investment on restoration or conservation programs until the economy stabilized. It is important to realize that WBCC's first approach was essentially focused on the ecological component of the system. However, these systems are susceptible to external variables such as global markets that determine prices and therefore sales, thus proving the vulnerability of any system where components are treated in isolation (Chapin et al. 2009). This unexpected but nonetheless learning process led to the creation of an education and knowledge transfer program for delivering best management practices to producers through the recognition and valuation of native local biodiversity and coupled ecosystem services (Fig. 19.3a).

These WBCC workshops highlighted two important things. The first was to realize how some inherited agricultural practices from the northern hemisphere were so ingrained that Chilean biodiversity had suffered dire consequences over time. The second was the keen interest and participation of farm workers to link biodiversity with their local ecological knowledge and cultural identity. As a result of these workshops and long-term engagement with wine producers, many of the vineyards associated with the program have already set aside areas that contain native forest and shrubland, approaching nearly 20,600 ha in a region where the National System of Protected Areas includes only 64,930 ha in National Parks (CONAF 2013). However, the WBCC program is still voluntary and has not been adopted by the Chilean wine industry as a whole, a situation that contrasts with South Africa (Von Hase et al. 2010).

A survey conducted with an open sample of Chilean wineries has shown that land set aside for conservation proposes is not a rare practice. Out of 45 surveyed wineries, 86 % claimed to have conservation areas on their farms. However, when asked about specific management practices to preserve biodiversity, we found out that only 35 % took steps to ensure that cattle were not allowed into these areas. This common practice in farmlands is based in the erroneous belief that cattle will remove grass biomass and therefore decrease the risk of fires. However, this practice not only severely limits the recruitment of native flora (Henriquez and Simonetti 2001), but it increases propagation of invasive grasses that are highly flammable (Pauchard et al. 2008, 2011). The introduction of nonnative species is of particular concern in Chile, given that 15 % of plant species present in the country are nonnative (Fuentes et al. 2013). Chile has a strict quarantine control over pests, and there is a clear normative to avoid the introduction of exotic species without a permit. However, a national strategy for control and prevention of exotic invasive species based on the damage that can be caused to the native biodiversity, has not been implemented (Pauchard et al. 2011).

Implementation of cover cropping between roads that might involve exotic species can be nevertheless a beneficial practice that prevents soil erosion, improves soil conditions, and provide habitat for natural enemies (Altieri 1999; Nicholls et al. 2001; Patrick-King and Berry 2005). When choosing species for this purpose, commercial mixes, such as those that are used in California, USA, are the only available

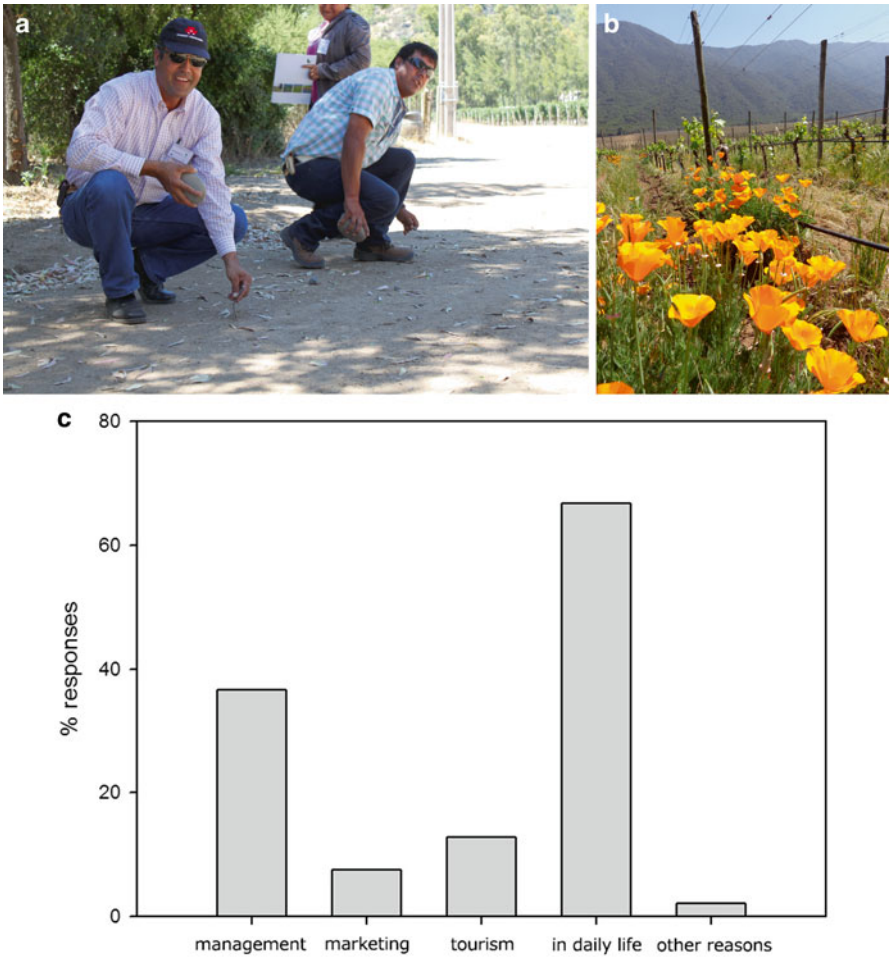

Fig. 19.3 (**a**) Workshop activities using the inquiry methodology (Feinsinger 1987), evaluating soil compaction between vineyards, road and native forest. (**b**) The use of *Eschscholzia californica* as a cover crop in farms that sustain high native species richness in surrounding areas, risking valuable ecosystems. Flower remains up to 4 years after initial seed plantation. (**c**) Interviews post workshops showing responses on "in which areas they would like to apply what they learned during this" (n = 98)

commercial options. One of the most popular mixes of cover crops includes *Eschscholzia californica,* even though it is a highly invasive species (Peña-Gómez and Bustamante 2012). The use of *E. californica* is common and has an ability to grow everywhere. For this reason, it has been propagated by some wine producers who have collected local seeds from roadways and trainlines because they believed erroneously that this would contribute to preserving local genetic diversity (Fig. 19.3b). Therefore they were applying correct restoration techniques but with

the wrong species. After wine producers enrolled in the program, they demanded seedmixes without this invasive species. Currently, the development of cover crop mixes with native species, which do not actually exist, is taking place.

In summary, the way in which stewardship is understood and put into practice requires knowledge of local ecosystems, a knowledge that may or may not be available. As some (or probably most) historically used practices that are not good for biodiversity conservation in the Chilean Mediterranean ecosystem are inherited from the global north, local research is extremely important (Rozzi et al. 2012). On the other hand, it has been demonstrated that the main motivations for companies to "go green" are competiveness, legitimation, and ecological responsibility. These motivations are influenced, among other reasons, by individual concern (Bansal and Roth 2000). For these reason, the approach used in workshops has been very valuable in part because it is based on the inquiry methodology of Schoolyard Ecology, in which participants experience the process of learning through their own practices (Feinsinger 1987; Feinsinger et al. 1997). This also has made it possible to work horizontally during workshops, with all employees of the winery and vineyard, and enabling local workers to rediscover and validate their local ecological knowledge without regard to any corporate rank order. In addition these workshops have contributed to corporate social responsibility strategies (CSR) and provide a potential avenue for extending these educational programs to the local community. Indeed, interviews conducted with participants after the workshops indicate that 88 % of respondents believe that protecting native biodiversity inside their farm contributes to conservation goals. Moreover, when asked "in which areas they would like to apply what you learned during this" workshop, 67 % responded "in daily life" (Fig. 19.3c). This shows that enhancing stewardship in vineyard practices can have an extended effect into broader areas.

After this experience, it is strongly believed that diversification of knowledge transfer, in which the variety of individual motivations for conservation are acknowledged (e.g. from CSR to cultural ancestral value) has been one of the reasons why these workshops have been valued greatly by wineries in the program. Through this type of strategies almost all participants find some cultural connection to the environment, which has also been regarded as a powerful social force fostering stewardship and social-ecological sustainability (Berkes et al. 2000; Chapin 2009b). Despite the success of this initiative, the lack of institutional incentives for conservation of private lands remains a real threat to this voluntary strategy.

19.3 Awakening into Biodiversity Leads to Urban and Rural Earth Stewardship

Both study cases show that through capacity building activities with local community, we could rely on a bottom-up approach to improve knowledge about wetland values in Valdivia and natural landscapes around vineyards. However, the combined effect, with a top-down approach (government institutions and corporations),

increases the effectiveness of the decision making process. People's knowledge and past experiences influence people's perception (Kaplan et al. 1998), and people's perception influence people's values, attitudes and actions towards caring for the environment (Nassauer 1995a, b; Rozzi 2013). This complementary bottom-up and top-down approach can lead to earth stewardship through increasing community awareness of the diverse values derived from ecosystems.

The socio ecological approach in both study cases has also generated an aesthetic experience, which can be scenic (awareness through landscape beauty) or ecological (awareness through enhanced knowledge of ecosystems) aimed at engaging the community in earth stewardship. Other studies have demonstrated that, for example, an ecological aesthetic approach has been widely used as an educational tool for improving attitudes toward fire management practices in environments where fire is an aid to biodiversity (Gobster 1994). A growing ecological aesthetic (*sensu* Gobster et al. 2007) has also grown in wine producers, and has contributed to improving the interrelationships between ecology and wine production, by incorporating values that lack an evident relationship to economic incentives (e.g. native flora in case of the wineries). Other urban studies also suggest that a scenic aesthetic, can be an effective catalyst for earth stewardship (Felson et al. 2013).

Biophysical landscape elements play a part in the valuation of urban ecosystems, regardless of their 'ugly' and 'dirty' appearance. They are known as 'cues to care' (Nassauer 1995b), or familiar landscape elements which can first trigger people's attraction for landscape and then develop over time a deep concern for it. In the case of Valdivia, the cues to care in urban wetlands are missing, but are much needed to improve the interrelationships between people and wetland systems for earthquake recovery.

In the same way, the intentionality to sustain animal and plant production for human use, underscores the social-ecological connection that has been going for at least 10,000 years, when domestication began (Smith 1998; Naylor 2009). An holistic approach to Earth stewardship should consider a variety of values, and undertake socio-ecological a socio-ecological approach.

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