

Chapter 13

Sustainability, resilience and quality of life

You will always have the poor among you. John 12:8

The way of the Lord is not just, they cried. Ezekiel 33:17

For what shall it profit a man, if he shall gain the whole world, and lose his own soul? Mark 8:36

For I was hungry and you gave me something to eat . . . “Then the righteous will answer him, ‘Lord, when did we see you hungry and feed you . . . ‘Truly I tell you, whatever you did for one of the least of these brothers and sisters of mine, you did for me.’ Matthew 25:35-40

The world cries out for justice, how can we not answer? Children are dying, how can you sit idly by? Such sentiments provide an inescapable impulse to go beyond ecological resilience to consider the quality of life parameters. Such sentiments also underlie why sustainability is a wicked problem³⁷⁰ and resilience is not. Wicked problems, as discussed tangentially in other chapters, have several characteristics: they must be solved before they can be understood, every example of the problem is unique, and there is no immediate and no ultimate test of a solution due in large part to polarized stakeholders with conflicting values precluding any agreement on criteria to determine when a solution is found.³⁷¹ Climate change is a classic wicked problem³⁷² as are most situations of environmental degradation, overpopulation, endangered species, poverty, and food security.

Solving one wicked problem (whether to suppress fire in sustainable yield forestry) led to the concept of ecological resilience.³⁷³ As discussed in the previous chapter, ecological resilience avoids the polarizing aspects of sustainability with a measureable biological reality: the amount of disturbance a system can take before it dissolves without being able to reconstitute itself. The resilient system survives, the non-resilient does not.

³⁷⁰ Paulson, J., 2010. Sustainability is a wicked problem, Dairy Star, July 16, 2010.

³⁷¹ Rittel, H. W., & Webber, M. M. 1973. Dilemmas in a general theory of planning. Policy Sciences, 4(2): 155–169.

³⁷² World Bank, 2014. <http://www.worldbank.org/en/news/feature/2014/09/30/a-wicked-problem-controlling-global-climate-change>; Lazarus, R.J., Super wicked problems and climate change: restraining the present to liberate the future. Cornell Law Review, 94:1153-1234. <http://www.lawschool.cornell.edu/research/cornell-law-review/upload/Lazarus.pdf>; Levin, K., Cashore, B., Bernstein, S., and G. Auld, 2012. Overcoming the tragedy of super wicken problems: constraining our future selves to ameliorate global climate change. Policy Sciences, 45:123-152. <http://link.springer.com/article/10.1007%2Fs11077-012-9151-0>.

³⁷³ Holling, C.S. and G. K. Meffe, 1996. Command and Control and the Pathology of Natural Resource Management. Conservation Biology 10:328–33.

If one adheres to the standard definition of resilience (ability to withstand disturbance) ecological resilience assessment differs from sustainability assessment in one basic area. Resilience assessments will not incorporate indicators unless they are associated with the ability of a system to withstand disturbance. The holy grail of resilience measurement is a set of indicators of the key qualities of ecological resilience across scales and types of systems, including soils and wildlife systems (see Chapter 11). Indicators regarding human social demographics, no matter how important they are, therefore cannot be indicators of basic and universal qualities of resilience.

Sustainability assessments include a variety of indicators which express normative or aspirational conditions which many deem valuable. Sustainable systems are variously defined as those which increase quality of life (United States Congress in 1990³⁷⁴), increase economic well-being and social equity³⁷⁵ and other socially desirable outcomes (White House, 2015³⁷⁶).

Quantitative measures of resilience such as SRI allow correlation of resilience with the variety of social indicators included in more standard definitions of sustainability. Such analyses show the relationship of resilience to socially desirable characteristics which are only indirectly reflected in the fundamental qualities of resilience. These social demographic indicators appear correlated with resilience from our preliminary data. SRI enables us to explore the relationship of resilience to measures of poverty, health, population, and other human social demographic variables.

Other social demographic variables such as education levels or population trends, though not included in most definitions of sustainability, also have interesting relationships to SRI.

Correlations of these various social demographic indicators with resilience are shown in the tables in this chapter. Look at the data and see the relationship between the SRI and indicators of health, poverty, education, and population. **One conclusion is that resilient systems (at least at the county level as measured by SRI) generally are accompanied by low poverty and high health outcomes.**

Health and ecological resilience. We used two different measures of correlation and came out with basically the same results on each measure on two different health measure. A crucial health indicator for resilience is birth outcomes. Birth outcomes (see Methods) reflect the overall health and resilience of the mother in her community. The correlation of SRI and birth outcomes is extremely high for demographic data. More resilient counties are like to have good birth outcomes. Answering why is difficult. Examining some of the components of resilience may provide part of the answer. Only two of the individual indicator databases used to determine SRI scores were higher than the overall index correlation, as shown in the above box. Rotation grazing had the highest correlation with birth outcomes. An associated measure, percent of operations with animals was second highest. Counties

³⁷⁴ 1990 Farm Bill [Food, Agriculture, Conservation, and Trade Act of 1990 (FACTA), Public Law 101-624, Title XVI, Subtitle A, Section 1603 (Government Printing Office, Washington, DC, 1990).

³⁷⁵ Toman, M., Lile, R. and D. King, 1998. Assessing Sustainability: Some Conceptual and Empirical Challenges. Washington, D.C.: Resources for the Future. <http://www.rff.org/files/sharepoint/WorkImages/Download/RFF-DP-98-42.pdf>.

³⁷⁶ <https://www.whitehouse.gov/the-press-office/2015/03/19/executive-order-planning-federal-sustainability-next-decade>.

with the most positive birth outcomes had a higher percent of operations with animals (a measure of diversity), especially those using the practice of ecological integration known as management intensive grazing. The third highest correlation was with a component of the locally self-organized quality—whether the principal operator lived on the farm.

The fact that the overall SRI was nearly as high as the highest components while many components have extremely low correlations appears to indicate that the index, by incorporating many unrelated components, is enabling measurement of a concept which reaches beyond any individual component.

Correlations with of SRI with Low Birth Outcomes Per 100 Live Births (2013 3-Year Estimates)		
Sustainability/Resilience Index and Components	Spearman's Rank	Kruskal's Gamma
Percent Operations with Sales, Animals	-.330**	-.321**
Percent of Operations Principal Operators Residence on Farm	-.263**	-.278**
Percent of Farm Operations with Rotational or Management-Intensive Grazing Practices	-.341**	-.373**
Sustainability/ Resilience Index	-.314**	-.313**
Notes: * =Correlation is significant at the 0.05 level (2-tailed). ** =Correlation is significant at the 0.01 Level (2-tailed).		

Correlation Coefficients Between Sustainability/Resilience and Health		
	Low Birth Outcomes Per 100 Live Births (2013 3-Year Estimates)	
Sustainability/Resilience Index and Components	Spearman's Rank	Kruskal's Gamma
Percent of Operations Principal Operators Residence on Farm	-.263**	-.278**
Farmer Alternatives Scale	-.117**	-.102**
Community Alternatives Index	-.148**	-.180**
Percentage Change in the Value of Farm Machinery Between 2007 and 2012	.102**	.111**
Age Redundancy	-.068*	-.091**
Percentage Change in the Number of Farms Between 2007 and 2012	-.099**	-.099**
Average Percent of Operations Producing Row Crops Across Seven Different Options	.128**	.139**
Percent Operations with Area Harvested, Vegetables	.213**	.240**
Percent Operations with Sales, Animals	-.330**	-.321**
Production Diversity Index Across Row Crop, Vegetables, and Livestock	.006	.020
Percent of Cropland Acres Not Treated with Herbicide	-.025	-.035
Percent of Cropland Acres Not Treated with Insecticide	-.216**	-.227**
Average of Z scores for No Herbicide and No Insecticide	-.141**	-.153**
Percent Operations USDA Certified Organic	-.129**	-.207**
Percent of Farm Operations with Rotational or Management-Intensive Grazing Practices	-.341**	-.373**
Percent of Operations with Internet Access	-.210**	-.216**
Sustainability/ Resilience Index	-.314**	-.313**
Notes: *=Correlation is significant at the 0.05 level (2-tailed). **=Correlation is significant at the 0.01 Level (2-tailed).		

The Birth outcomes measure is a direct measure of health of babies in a county. No such direct measure is available for overall health of residents, but a database does exist which details self-reported health at the county level. This measure of overall health was also highly correlated with SRI, though

not as highly as the direct measure of birth outcomes. Counties where residents reported being in good health are more likely to have high SRI scores. The following table shows the negative correlation of poor health and SRI.

Correlations with Percent of Adults With Self-reported Poor or Fair Health (2012 5-Year Estimates)		
	Spearman's Rank	Kruskal's Gamma
Farmer Alternatives Scale	-.260**	-.237**
Community Alternatives Index	-.300**	-.328**
Percent Operations USDA Certified Organic	-.215**	-.357**
Percent of Operations with Internet Access	-.397**	-.423**
Sustainability/Resilience Index	-.241**	-.251**

None of the components of SRI which had higher correlations with birth outcomes also were in the highest categories of self-reported health. As shown in the above box, the components of SRI which correlated most highly were farmer internet access, a measure of the modular connectivity quality of resilience, two measures of local self-organization (community and farmer organized processing and marketing) and one measure of ecological integration (percent with certified organic operations).

Many studies do indicate the presence of farmers markets (community organized marketing) is correlated with more consumption of healthy foods³⁷⁷ and a recent review of 343 studies published in the British Journal of Nutrition³⁷⁸ found that organic foods are more healthful than conventional foods, mainly because the former contain higher concentrations of antioxidants, while the latter contain higher levels of the toxic metal cadmium.

The highest correlations with self-reported health, however, was the modular connectivity indicator, percent of farms with internet access. Since farm internet access likely means access for nonfarmers, perhaps access to information about health-related topics is higher in resilient counties. However, these explanations are merely hypotheses and must be tested further.

³⁷⁷ Traub, A., 2011. http://ocw.jhsph.edu/courses/capstone2011/PDFs/Traub_Arielle_2011.pdf; Obadia, J. and J. Porter, http://bostonfarmersmarkets.org/wp-content/uploads/2012/07/FarmersMarket-Impact-on-FV_Website.pdf; Evans AE, Jennings R, Smiley AW, et al. Introduction of farm stands in low-income communities increases fruit and vegetable among community residents. *Health & Place*. 2012;18(5):1137-43; Racine EF, Smith Vaughn A, Laditka SB. Farmers' market use among African-American women participating in the special supplemental nutrition program for women, infants, and children. *Journal of the American Dietetic Association*. 2010;110(3):441-6; Ruelas V, Iverson E, Kiekel P, Peters A. The role of farmers' markets in two low income, urban communities. *Journal of Community Health*. 2012;37(3):554-62.

³⁷⁸ Baranski, M. et al., 2014. Higher antioxidant and lower cadmium concentrations and lower incidence of pesticide residues in organically grown crops: a systematic literature review and meta-analyses. *Br J Nutr*. 2014, 112:794-811. doi: 10.1017/S0007114514001366.

Correlation Coefficients Between Sustainability/Resilience and Health	
	Percent of Adults With Poor or Fair Health (2012 5-Year Estimates)
Sustainability/Resilience Index and Components	Spearman's Rank
Percent of Operations Principal Operators Residence on Farm	-.050
Farmer Alternatives Scale	-.260**
Community Alternatives Index	-.300**
Percentage Change in the Value of Farm Machinery Between 2007 and 2012	.009
Age Redundancy	.170**
Percentage Change in the Number of Farms Between 2007 and 2012	-.072*
Average Percent of Operations Producing Row Crops Across Seven Different Options	.046
Percent Operations with Area Harvested, Vegetables	-.059*
Percent Operations with Sales, Animals	.056
Production Diversity Index Across Row Crop, Vegetables, and Livestock	.020
Percent of Cropland Acres Not Treated with Herbicide	.094**
Percent of Cropland Acres Not Treated with Insecticide	.064*
Average of Z scores for No Herbicide and No Insectide	.077**
Percent Operations USDA Certified Organic	-.215**
Percent of Farm Operations with Rotational or Management-Intensive Grazing Practices	-.080**
Percent of Operations with Internet Access	-.397**
Sustainability/Resilience Index	-.241**

Poverty and resilience. Many dedicated to eradicating poverty believe that lack of resources produce a lack of resilience. Some believe poverty is just a lack of money.³⁷⁹ Others believe a lack of resilience produces a lack of resources.³⁸⁰ Fighting poverty is one of those wicked issues where people are polarized. Some feel it is the poor person’s fault--that they need to pull themselves up by their bootstraps. Others feel we should have compassion and give the poor what they need.

As usual in any polarized situation, the solution is often to come up with a more basic organizing assumption which unites the polarized groups. Then we build on this new assumption.

Maybe something more basic is causing both a lack of resilience and poverty. Maybe the poverty warriors need to look at natural ecological systems.

We found that our Sustainability/Resilience Index (SRI) was highly correlated with lack of poverty in Southern counties. In addition, all components of SRI, except one (internet access) were much lower than the overall SRI correlation with both measures of poverty we examined, as shown in the box below.

Correlation Coefficients Between Sustainability/Resilience and Poverty			
Sustainability/Resilience Index and Components	Income and Benefits (in 2012 Inflation-Adjusted Dollars), Median Household Income (Dollars)	Families Whose Income in the Past 12 Months is Below the Poverty Level	Gini Index Estimate
Percent of Operations Principal Operators Residence on Farm	.103**	-.152**	-.209**
Farmer Alternatives Scale	.215**	-.199**	-.051
Community Alternatives Index	.200**	-.183**	.047
Percent of Farm Operations with Rotational or Management-Intensive Grazing Practices	.163**	-.239**	-.146**
Percent of Operations with Internet Access	.375**	-.289**	-.098**
Overall Resilience (SRI)	.239**	-.279**	-.147**

Overall SRI is highly correlated with median income and negatively correlated with families in poverty. Resilient agricultural systems are associated with low levels of poverty. The two components of resilience most highly correlated with income and low poverty are the locally self-organized (LSO) and modular connectivity components.

For income and poverty, the highest correlations with LSO are farmer-organized processing and marketing and community-organized processing and marketing. These findings are echoed in numerous international development studies which show that resilient food systems are all locally self-organized.

³⁷⁹ <http://www.sociology.org/what-causes-poverty/>

³⁸⁰ Hobfall, S.F., 1989. Conservation of Resources: A New Attempt at Conceptualizing Stress. American Psychologist, 44:513-524. <http://www.personal.kent.edu/~shobfall/Files/pdfs/AP1989CORnewattempt.pdf>.

By providing food aid from outside, we undermine local self-organization and so undermine resilience.³⁸¹ President Bill Clinton, after leaving office, realized that international aid efforts he had promoted “might have helped Arkansas farmers,” but exacerbated the problem of food insecurity in developing countries.³⁸² The Obama Administration has taken those lesson learned to heart. The Feed the Future initiative of USAID³⁸³ supports purchase of local food instead of importing food. Whether this initiative increases food system resilience in developing countries will depend on whether the other qualities of resilient systems are also strengthened.

We need to let others organize themselves in ways that fit their ecosystems. Instead, we impose our values and our resources on them. Our values and our resources may work for our society, but other societies need to organize their own.

Our data also indicate that modular connectivity is highly related to poverty and income. The one measure available at a county level in the South is more highly correlated with income and more negatively correlated with poverty than any other component and even the overall SRI.

But by itself, local self-organization is not sufficient if to facilitate resilient systems. The eight qualities are all necessary for resilience, but local self-organization appears to be the linchpin.

We also examined the correlation of SRI with the Gini index--a measure of statistical dispersion intended to represent the income distribution of a nation's residents, and is the most commonly used measure of inequality. SRI and the Gini Index were negatively correlated, though not nearly as highly correlated as was lack of poverty and SRI. SRI is related to lack of inequality. In addition, only one component of SRI (managers living on their farms) was more highly correlated with inequality than the overall SRI. If farmers live on their land, Southern counties are less likely to have a huge spread in incomes. Teasing out the causes of the relationship awaits more in depth study.

³⁸¹ <http://www.fao.org/publications/sofa/2006/en/>

³⁸² Fuller, A., 2015, Haiti on its Own Terms. National Geographic, December 2015, p. 112.

³⁸³ <http://www.feedthefuture.gov/>

Correlation Coefficients Between Sustainability/Resilience and Poverty			
	Income and Benefits (in 2012 Inflation-Adjusted Dollars), Median Household Income (Dollars)	Families Whose Income in the Past 12 Months is Below the Poverty Level	Gini Index Estimate
Percent of Operations Principal Operators Residence on Farm	.103**	-.152**	-.209**
Farmer Alternatives Scale	.215**	-.199**	-.051
Community Alternatives Index	.200**	-.183**	.047
Percentage Change in the Value of Farm Machinery Between 2007 and 2012	-.017	.032	.020
Age Redundancy	-.095**	.049	-.043
Percentage Change in the Number of Farms Between 2007 and 2012	.106**	-.106**	-.052
Average Percent of Operations Producing Row Crops Across Seven Different Options	-.097**	.087**	-.025
Percent Operations with Area Harvested, Vegetables	-.047	.081**	.066*
Percent Operations with Sales, Animals	.042	-.135**	-.100**
Production Diversity Index Across Row Crop, Vegetables, and Livestock	-.042	-.009	-.056*
Percent of Cropland Acres Not Treated with Herbicide	-.033	-.021	-.004
Percent of Cropland Acres Not Treated with Insecticide	.061*	-.124**	-.086**
Average of Z scores for No Herbicide and No Insecticide	.010	-.076**	-.048
Percent Operations USDA Certified Organic	.141**	-.115**	-.042
Percent of Farm Operations with Rotational or Management-Intensive Grazing Practices	.163**	-.239**	-.146**
Percent of Operations with Internet Access	.375**	-.289**	-.098**
Overall Resilience (SRI)	.239**	-.279**	-.147**
Notes: *=Correlation is significant at the 0.05 level (2-tailed). **=Correlation is significant at the 0.01 Level (2-tailed).			

Education and resilience

The locally self-organized quality (as indicated by community processing and marketing and farmer organized processing and marketing) and modular connectivity (internet access) are both correlated

with education, but overall SRI not as highly correlated with education. Education does explain some components of overall resilience, but not nearly as much does it explain total resilience.

Correlations of SRI and components with education	
	Educational Attainment, Bachelor's Degree or Higher
Farmer Alternatives Scale	.215**
Community Alternatives Index	.394**
Percent of Operations with Internet Access	.363**
Overall Resilience (SRI)	.194**

Population and resilience. As you've heard many times in this book, resilience is how much disturbance a system can take before it is destroyed. Measuring resilience is simple if you are willing to destroy the system--just increase a disturbance until the system is destroyed. But since we want to help systems transform to avoid destruction, we have to come up with a different measurement system.

Our research has discovered eight qualities which are necessary to resilient systems. Increasing these qualities leads to more resilience. Responsive redundancy is one of the qualities. In ecological terms, redundant systems are those which do a good job of reproducing themselves. Each of the species in the system is prolific. But in ecologically resilient systems, the redundancy is controlled. Population explosion is prevented by the controls of predators. Populations of those at the top of the food chain are hampered by the lack of food. Animals have fewer offspring when food is not available.

Human populations used to have similar controls. In the mountains of Southern Ethiopia the Konso people have created a permaculture system which has fed their people for untold generations. Their terraced fields build soil, conserve water, and stop erosion. They use agroforestry and intercropping with more species than virtually any American farmer. They traditionally controlled population by only permitting pregnancy to those who are members of a particular generation grade and limiting members of this group. Some of their methods aren't comfortable to Westerners. Instead we use chemical and physical birth control. After contact with Westerners the Konso abandoned their traditions with the result of huge population increases and dependence on foreign food aid.³⁸⁴

We are so sure our values are right, that we have convinced the Konso and other peoples to abandon values which made their societies resilient. To promote resilience, we need to let others organize themselves in ways that fit their ecosystems. All too often, we impose our values and our resources on them. Our values and our resources may work for our society, but other societies need to organize their own.

Ecologically resilient systems can have a complex relationship with population. When technology change is stagnant, resilient societies must have a stable to very slightly increasing population with regular fluctuations depending on drought and other factors.

³⁸⁴ Forch, W. 2003. Case Study: The Agricultural System of the Konso in Southwestern Ethiopia. <https://www.uni-siegen.de/zew/publikationen/volume0103/1-wiebke-konso-pubs.pdf>.

However, in agroecological systems where technology change is rapid, resilient systems can attract migration from other non-resilient areas. Excessive migration, however, puts pressure on availability of farmland leading to reduced resilience as we saw in Chapters Six and Seven.

In the counties of the Southern U.S., population trends have relationships to the components of resilience which are similar to those of education, though managers living on their farms is also correlated with population trends.

However, population trends are much more highly correlated with SRI and its components than education, or poverty. People appear to want to move to areas with highly sustainable/resilient agricultural systems.

Correlations of Population Trends with SRI and resilience components		
	Total Migration Rate	2010 Population
Percent of Operations Principal Operators Residence on Farm	.358**	.271**
Farmer Alternatives Scale	.253**	.286**
Community Alternatives Index	.282**	.541**
Percent of Operations with Internet Access	.248**	.247**
Overall Resilience (SRI)	.356**	.284**

Migration to counties correlated highly with high SRI, all the indicators of LSO and modular connectivity. Though total population was correlated the same components of resilience, it was not nearly so highly correlated with SRI. One extremely high correlation (with community organized processing and marketing) may be explained by the increased ability of areas with higher population to support farmers markets and other community organized processing and marketing. However, this high correlation did not bleed over into the overall resilience measure.

Understanding these relationships will require further study.

Correlations of Education and Population Trends with SRI and resilience components			
	Educational Attainment, Bachelor's Degree or Higher	Total Migration Rate	2010 Population
Percent of Operations Principal Operators Residence on Farm	.062*	.358**	.271**
Farmer Alternatives Scale	.215**	.253**	.286**
Community Alternatives Index	.394**	.282**	.541**
Percentage Change in the Value of Farm Machinery Between 2007 and 2012	-.086**	-.180**	-.100**
Age Redundancy	-.162**	-.041	.001
Percentage Change in the Number of Farms Between 2007 and 2012	.044	.041	.004
Average Percent of Operations Producing Row Crops Across Seven Different Options	-.142**	-.065*	-.136**
Percent Operations with Area Harvested, Vegetables	.036	.158**	.220**
Percent Operations with Sales, Animals	-.015	.129**	-.004
Production Diversity Index Across Row Crop, Vegetables, and Livestock	-.056*	.125**	.035
Percent of Cropland Acres Not Treated with Herbicide	-.018	.023	-.034
Percent of Cropland Acres Not Treated with Insecticide	.026	.011	-.099**
Average of Z scores for No Herbicide and No Insecticide	.007	.027	-.070*
Percent Operations USDA Certified Organic	.148**	.180**	.193**
Percent of Farm Operations with Rotational or Management-Intensive Grazing Practices	.077**	.275**	.060*
Percent of Operations with Internet Access	.363**	.248**	.247**
Overall Resilience (SRI)	.194**	.356**	.284**
Notes: *=Correlation is significant at the 0.05 level (2-tailed). **=Correlation is significant at the 0.01 Level (2-tailed).			