Macro-socio-ecology-outline

Tuesday, June 25, 2015

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1 ABSTRACT

Increasing human pressure on the planet from population, extractive and consumptive activity leads to resource scarcity and risks of crossing so-called planetary boundaries putting the human specis, other species and the entire earth system at risk. Further, with increasing demand of both continuing economic and social development along with a good and healthy environment and resources for the future - the need for a macroscopic view on how human resource use relates to the state of environment, as well as social and economic outcomes is needed.

The socio-ecological approach considers human activities as embedded and interacting with the biosphere. Socio-ecological systems have historically been considered when humans interact with the environment in extractive activities, often in marine or forest ecosystems.

At the core of the socio-ecological systems approach are questions about the dynamics of how governance systems affects the way humans interact with the environment and what they get out of their interaction with the environment.

Socio-ecological approaches, however, have a history of having been applied largely to local dynamics and to simple systems that can be analyzed analytically. As such, the socio-ecological approach has not delivered a guiding framework for how society can co-evolve in the long-term from

the global to the national and regional scale.

In parrallel, global, regional or national frameworks for looking at socio-ecological dynamics have been developed. However, they have rarely been phrased explicitly as such.

Here we provide an overall framework for what can be considered a macro-socio-ecology. We tie together classic socio-ecological research with recent large scale approaches of similar character. We outline main research questions for macro-socio-ecology, its main methodological toolbox, and its policy and governance relevance.

National

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2 THE NEED

- Success of socio-ecology
- A strong micro-level foundation
- Recent foundational concepts
- Planetary boundaries
- Social foundation
- Doughnut economics
- A guiding national, regional and world map
- not a GPS that will tell you how to get to where you want
- To inspire discussions
    - About what we use our resources for
    - About the efficiency with which we use resources - environmental (extraction, transport), social, economic
- Plenty of data - fragile framework
    - The national, regional and global level of organization

2.0.1 **Environmental impact**

$I = PAT \Leftrightarrow I = PACT$

2.0.2 **Developmental outcome**

$D = PAE$

2.0.3 **Development outcome per environmental impact**

$\frac{D}{I} = \frac{PAE}{PAT} = \frac{E}{T}$

$\frac{D}{I} = \frac{PAE}{PACT} = \frac{E}{CT}$

2.0.4 Where are the resources?

Implicit in C & T

2.0.5 *Making resources explicit:*

$Resources, extracted: R_e, consumed: R_c, imported: R_i, exported: R_o$

$R_o + R_c = R_i + R_e$

2.0.6 Environmental, social and economic impacts of resource use

Using the same subscripts for I, D and economic measures Ec, for now denoting equity by Eq.

Total environmental impacts of resource use.

$$\frac{I}{R} = \frac{I}{R_o+R_c+R_i+R_e} = \frac{I_o}{R_o} + \frac{I_c}{R_c} + \frac{I_i}{R_i} + \frac{I_e}{R_e}$$

Similar statements apply for Ec and D.

$$\frac{Ec}{R} = \frac{Ec}{R_o+R_c+R_i+R_e} = \frac{Ec_o}{R_o} + \frac{Ec_c}{R_c} + \frac{Ec_i}{R_i} + \frac{Ec_e}{R_e}$$

$$\frac{D}{R} = \frac{D}{R_o+R_c+R_i+R_e} = \frac{D_o}{R_o} + \frac{D_c}{R_c} + \frac{D_i}{R_i} + \frac{D_e}{R_e}$$

One or more of the flows may be (set to) null depending on the question or type of process investigated.

2.0.7 Net outcomes versus outcomes associated with consumption of resources gains and losses ass

2.0.8 Resource consumption elasticities of D, I, Ec

$\log(var) = a + b * \log(R_c)$

$elasticity = \epsilon = b$

Research question

Rank variables with regard to b. Assume other model than linear?

Variables with high cross-country resource elasticities should be scrutinized for more in-depth analysis. E.g. outliers within continents or development stages with partiularly high or low resource use per sustainability outcome.

2.0.9 Elasticity of consumed resources to consumption balance

$$\log(var) = a + b * \log(R_{ci}) + c * \log(R_{ce})$$

Where R_{ci} and R_{ce} are the resources consumed through imports and domestic extraction, respectively.

Assuming equal proportional contributions to export from extracted and imported resources

$$\log(var) = a + b * \log\left(R_i * \left(\frac{R_i}{R_c+R_o}\right)\right) + c * \log\left(R_e * \left(\frac{R_e}{R_c+R_o}\right)\right)$$

Assuming exports first by domestic resources, then by imported resources of vice versa

Needs to be filled in.

2.0.10 **Elasticity of consumption balance**

$$\log(var) = a + b * \log\left(\frac{(R_{ce}-R_{ci})}{(R_{ce}+R_{ci})}\right)$$

Where R_{ci} and R_{ce} are the resources consumed through imports and domestic extraction, respectively.

Assuming equal proportional contributions to export from extracted and imported resources

$$\log(var) = a + b * \log\left(\frac{(R_e-R_i)}{(R_e+R_i)} * \frac{(R_c)}{(R_c+R_o)}\right)$$

Assuming exports first by domestic resources, then by imported resources of vice versa

Needs to be filled in.

2.0.11 **Key national response variables**

2.0.11.1 Social variables

- **Raworth variables**
- *basic services*
- energy supply
    - Households without access to electricity (Raworth 2012, OXFAM South Africa report, Development Indicators 2012, Household Survey 2012, 2013)
    - Population lacking access to clean cooking facilities (OXFAM South Africa report, Development Indicators 2012, Household Survey 2012, 2013)
    - Fuel poverty - 10% or more of income required to be spent on all energy (OXFAM UK report)
        - 26% of households are in fuel poverty (GB 2013)
- housing

    - Households without formal dwellings (OXFAM South Africa report, Development Indicators 2012, Household Survey 2012, 2013)
    - Overcrowding (OXFAM UK report)
        - 3% of households are overcrowded (UK 2012-2013)
- sanitation
    - Population without access to improved sanitation (Raworth 2012)
    - Households without a toilet or ventilated pit latrine (OXFAM South Africa report, Development Indicators 2012, Household Survey 2012, 2013)
    - UNEP (1990-2009)
        - Population connected to wastewater treatment
            - WasteWaterTreatment2011.xls
        - Population connected to wastewater collecting system
            - WasteWaterCollect2011.xls
        - Municipal waste collected
            - MWCollect2011.xls
- water security / supply
    - Population without access to an improved drinking water source (Raworth 2012)
    - Households without access to piped water within 200m (>= Reconstruction and Development Programme standard; OXFAM South Africa report, Development Indicators 2012, Household Survey 2012, 2013)
    - UNEP variable (1990-2009)
        - Total population supplied by water supply industry
            - ISIC36_Pop2011.xls
- *livelihoods*
- income
    - Population living below the upper national poverty line (R577/month in 2011 Rand; OXFAM South Africa report, Development Indicators 2012, Household Survey 2012, 2013)
    - Population living below $1.25 (PPP) per day (Raworth 2012)
    - Households below 60% average income - after housing costs (HBAI-AHC; OXFAM UK report)
        - 22% of households are in relative poverty (UK 2013)
    - National level - GINI coefficient (e.g. from World Bank, estimates from 1980 to 2013).
    - *QoG variables*
    - **Maddison Project Database** The Maddison Project has launched an updated version of the original Maddison dataset in January 2013. The update incorporates much of the latest research in the eld, and presents new estimates of economic growth in the world economic between AD 1 and 2010. The new estimates are presented and discussed in Bolt and Van Zanden (2013).
    - 4.40.1 mad_gdp **GDP levels (million)** (N=158, 1946-2008). GDP levels (million): GDP levels in million 1990 International Geary-Khamis dollars. (The Geary- Khamis dollar is a

hypothetical unit of currency that has the same purchasing power that the U.S. dollar had in the United States at a given point in time).

    - 4.40.2 mad_gdppc **GDP per Capita** (N=158, 1946-2008). GDP per Capita in 1990 International Geary-Khamis dollars. (The Geary-Khamis dollar is a hypothetical unit of currency that has the same purchasing power that the U.S. dollar had in the United States at a given point in time).

- jobs - employment
    - Broad unofficial unemployment rate (adults aged 15-64 available to work; OXFAM South Africa report, Development Indicators 2012, Household Survey 2012, 2013)
    - Labour force not employed in decent work (Raworth 2012)
    - People lacking satisfying work (OXFAM UK report)
        - 19% of people lack satisfying work (UK 2014 Q3)
    - *QoG variables*
    - 4.56.55 wdi_unemplo **Unemployment, female (% of female labor force) (modeled ILO estimate)** (N=172, 1991-2012). Unemployment refers to the share of the labor force that is without work but available for and seeking employment.
    - 4.56.56 wdi_unempilo **Unemployment, total (% of total labor force) (modeled ILO estimate)** (N=172, 1991-2012). Unemployment refers to the share of the labor force that is without work but available for and seeking employment.
    - 4.56.57 wdi_unempmilo **Unemployment, male (% of male labor force) (modeled ILO estimate)** (N=172, 1991-2012). Unemployment refers to the share of the labor force that is without work but available for and seeking employment.
    - 4.56.58 wdi_unempylo **Unemployment, youth female (% fem 15-24)** (N=172, 1991-2012). ILO Youth unemployment refers to the share of the labor force ages 15-24 without work but available for and seeking employment.
    - 4.56.59 wdi_unempyilo **Unemployment, youth total (% of labor force ages 15-24) (ILO)** (N=172, 1991-2012). Youth unemployment refers to the share of the labor force ages 15-24 without work but available for and seeking employment.
    - 4.56.60 wdi_unempymilo **Unemployment, youth male (% fem 15-24)** (N=172, 1991-2012). Youth unemployment refers to the share of the labor force ages 15-24 without work but available for and seeking employment.
- *living standards*
- food security / supply - MDGs
    - Households without adequate food (OXFAM South Africa report, Development Indicators 2012, Household Survey 2012, 2013)
    - Population undernourished (Raworth 2012)
    - Adequate diet (as defined by PSE: UK; OXFAM UK report)
        - 7% of people cannot afford an adequate diet (UK 2012)
    - 4.56.10 wdi_dofdcal **Depth of the food decit (kilocalories per person per day)** (N=171, 1992-2013). The depth of the food decit indicates how many calories would be

needed to lift the undernourished from their status, everything else being constant. The average intensity of food deprivation of the undernourished, estimated as the dierence between the average dietary energy requirement and the average dietary energy consumption of the undernourished population (food-deprived), is multiplied by the number of undernourished to provide an estimate of the total food decit in the country, which is then normalized by the total population.

- household goods
    - Households without a refrigerator (OXFAM South Africa report, Development Indicators 2012, Household Survey 2012, 2013)
- safety
    - Households who feel unsafe walking alone in their area at night (OXFAM South Africa report, Development Indicators 2012, Household Survey 2012, 2013)
    - *QoG variables*
    - 4.9.2 ciri_disap **Disappearance** (1981-2011). Disappearances are cases in which people have disappeared, political motivation appears likely, and the victims have not been found. Knowledge of the whereabouts of the disappeared is, by denition ,not public knowledge. However, while there is typically no way of knowing where victims are, it is typically known by whom they were taken and under what circumstances. A score of 0 indicates that disappearances have occurred frequently in a given year; a score of 1 indicates that disappearances occasionally occurred; and a score of 2 indicates that disappearances did not occur in a given year.
    - 4.9.8 ciri_kill **Extrajudicial Killing** (1981-2011). Extrajudicial killings are killings by government ocials without due process of law. They include murders by private groups if instigated by government. These killings may result from the deliberate, illegal, and excessive use of lethal force by the police, security forces, or other agents of the state whether against criminal suspects, detainees, prisoners, or others. A score of 0 indicates that extrajudicial killings were practiced frequently in a given year; a score of 1 indicates that extrajudicial killings were practiced occasionally; and a score of 2 indicates that such killings did not occur in a given year.
    - 4.9.10 ciri_physint **Physical Integrity Rights Index** (1981-2011). This is an additive index constructed from the Torture, Extrajudicial Killing, Political Imprisonment, and Disappearance indicators. It ranges from 0 (no government respect for these four rights) to 8 (full government respect for these four rights).
    - 4.9.14 ciri_tort **Torture** (1981-2011). Torture refers to the purposeful inicting of extreme pain, whether mental or physical, by government ocials or by private individuals at the instigation of government ocials. Torture includes the use of physical and other force by police and prison guards that is cruel, inhuman, or degrading. This also includes deaths in custody due to negligence by government ocials. A score of 0 indicates that torture was practiced frequently in a given year; a score of 1 indicates that torture was practiced occasionally; and a score of 2 indicates that torture did not occur in a given year.
    - 4.23.1 gd_ptsa **Political Terror Scale - Amnesty International** (N=188, 1976-2012, [1:5]). Political Terror Scale Levels: 5. Terror has expanded to the whole population. The leaders of these societies place no limits on the means or thoroughness with which they pursue personal or ideological goals. 4. Civil and political rights violations have expanded

to large numbers of the population. Murders, disappearances,and torture are a common part of life. In spite of its generality, on this level terror aects those who interest themselves in politics or ideas. 3. There is extensive political imprisonment, or a recent history of such imprisonment. Execution or other political murders and brutality may be common. Unlimited detention, with or without a trial, forpolitical views is accepted. 2. There is a limited amount of imprisonment for nonviolent political activity. However, few persons are aected, torture and beatings are exceptional. Political murder is rare. 1. Countries under a secure rule of law, people are not imprisoned for their view, and torture is rare or exceptional. Political murders are extremely rare.

    - 4.23.2 gd_ptss **Political Terror Scale - US State Department** (N=188, 1976-2012, [1:5]). Political Terror Scale Levels: 5. Terror has expanded to the whole population. The leaders of these societies place no limits on the means or thoroughness with which they pursue personal or ideological goals. 4. Civil and political rights violations have expanded to large numbers of the population. Murders, disappearances,and torture are a common part of life. In spite of its generality, on this level terror aects those who interest themselves in politics or ideas. 3. There is extensive political imprisonment, or a recent history of such imprisonment. Execution or other political murders and brutality may be common. Unlimited detention, with or without a trial, forpolitical views is accepted. 2. There is a limited amount of imprisonment for nonviolent political activity. However, few persons are aected, torture and beatings are exceptional. Political murder is rare. 1. Countries under a secure rule of law, people are not imprisoned for their view, and torture is rare or exceptional. Political murders are extremely rare.

- *public goods*
- education (coverage) - MDGs
    - Adults without more than seven years of schooling (adult illiteracy; OXFAM South Africa report, Development Indicators 2012, Household Survey 2012, 2013)
    - Children not enrolled in primary school (Raworth 2012)
    - Children enrolled in tertiary education (Raworth 2012)
    - Illiteracy among 15-24-year-olds (Raworth 2012)
    - Adults lacking any formal qualifications (UK OXFAM report)
        - 23% of adult population lack any formal qualification (women 25%, men 20%) (UK 2011)
    - *QoG variables*
        - bl_asy25f Average Schooling Years, Female (25+) (1950-2010, every 5 years)
        - bl_asy25mf Average Schooling Years, Female and Male (25+) (1950-2010, every 5 years)
        - **UNESCO Institute for Statistics** UIS Data Centre, which provides access to our new data base, UIS.Stat, from where we extracted the data.
        - 4.51.1 une_durce **Duration, compulsory education** (N=183,1998-2013). Duration, compulsory education.
        - 4.51.2 une_durp **Duration, primary** (N=195,1998-2013). Duration, primary education.

        - 4.51.3 une_durpp **Duration, pre-primary** (N=195,1998-2013). Duration, pre-primary.
        - 4.51.4 une_durs **Duration, secondary** (N=195,1998-2013). Duration, secondary.
        - 4.51.5 une_gerppt **Gross enrollment ratio, pre-primary, total** (N=188, 1970-2013). Gross enrollment ratio, pre-primary, total.
        - 4.51.6 une_gerpt **Gross enrollment ratio, primary, total** (N=188, 1970-2013). Gross enrollment ratio, primary, total.
        - 4.51.7 une_gerst **Gross enrollment ratio, secondary, total** (N=188, 1970-2013). Gross enrollment ratio, secondary, total.
- health - public health variables, including Millennium Development Goals
    - Infant immunisation coverage (OXFAM South Africa report, Development Indicators 2012, Household Survey 2012, 2013)
    - Population estimated to be without regular access to essential medicines (Raworth 2012)
    - Physical health: Years of healthy life expectancy (HLE; OXFAM UK report)
        - People in the most deprived areas have 15% less than the average number of years of HLE (England 2012)
    - Mental health: Anxiety levels (OXFAM UK report)
        - 20% of adults had recently experienced a high level of anxiety (women 22%, men 18%) (UK 2013-2014)
    - *CoQ variables*
    - 4.51.8 une_hiv **HIV rate in adults (15-49 years)** (N=146, 1999-2011). HIV rate in adults (15-49 years).
    - 4.51.9 une_imr **Infant mortality rate** (N=190, 1999-2011). Infant mortality rate.
    - 4.51.10 une_leb **Life expectancy at birth** (N=186, 1999-2011). Life expectancy at birth.
    - 4.56.36 wdi_mortuf **Mortality rate, under-5 (per 1,000 live births)** (N=196, 1960-2012). Under-five mortality rate is the probability per 1,000 that a newborn baby will die before reaching age ve, if subject to current age-specic mortality rates.
- voice - governance variables?
    - People who do not feel free to say what they think (OXFAM South Africa report, Development Indicators 2012, Household Survey 2012, 2013)
    - Not defined (Raworth 2012)
    - *CoQ variables*
        - 4.9.1 ciri_assn **Freedom of Assembly and Association** (1981-2011). It is an internationally recognized right of citizens to assemble freely and to associate with other persons in political parties, trade unions, cultural organizations, or other special-interest groups. This variable indicates the extent to which the freedoms of assembly and association are subject to actual governmental limitations or restrictions (as opposed to strictly legal protections). A score of 0 indicates that citizens' rights to freedom of assembly or association were severely restricted or

denied completely to all citizens; a score of 1 indicates that these rights were limited for all citizens or severely restricted or denied for select groups; and a score of 2 indicates that these rights wer virtually unrestricted and freely enjoyed by practically all citizens in a given year.

- 4.9.4 ciri_empinx_new **Empowerment Rights Index (New)** (1981-2011). This is an additive index constructed from the Foreign Movement, Domestic Movement, Freedom of Speech, Freedom of Assembly and Association, Workers' Rights, Electoral Self-Determination, and Freedom of Religion indicators. It ranges from 0 (no government respect for these seven rights) to 14 (full government respect for these seven rights).
- 4.9.5 ciri_empinx_old **Empowerment Rights Index (Old)** (1981-2011). This is an additive index constructed from the Freedom of Movement, Freedom of Speech, Workers' Rights, Political Participation, and Freedom of Religion indicators. It ranges from 0 (no government respect for these ve rights) to 10 (full government respect for these ve rights). Note: Starting wit hthe 2007 coding, this variable was retired in favor of the newer index ciri_empinx_new.
- 4.9.11 ciri_polpris **Political Imprisonment** (1981-2011). Political imprisonment refers to the incarceration of people by government ocials because of their speech; their non-violent opposition to government policies or leaders; their religious beliefs; their non-violent religious practices including proselytizing; or their membership in a group, including an ethnic or racial group. A score of 0 indicates that there were many people imprisoned because of their religious, political, or other beliefs in a given year; a score of 1 indicates that a few people were imprisoned; and a score of 2 indicates that no persons were imprisoned for any of the above reasons in a given year.
- 4.9.13 ciri_speech **Freedom of Speech** (1981-2011). This variable indicates the extent to which freedoms of speech and press are aected by government censorship, including ownership of media outlets. Censorship is any form of restriction that is placed on freedom of the press, speech or expression. Expression may be in the form of art or music. A score of 0 indicates that government censorship of the media was complete; a score of 1 indicates that there was some government censorship of the media; and a score of 2 indicates that there was no government censorship of the media in a given year.
- 4.20.1 fh_cl **Civil Liberties** (N=207, 1972-2012, [1:7])Civil liberties allow for the freedoms of expression and belief, associational and organizational rights, rule of law, and personal autonomy without interference from the state. The more specic list of rights considered vary over the years. Countries are graded between 1 (most free) and 7 (least free).
- 4.20.3 fh_fotpsc5 **Freedom of the Press, Score (2001-2012)** (N=196, 2001-2012, [0:100]) The press freedom index is computed by adding three component ratings: Laws and regulations, Political pressures and controls and Economic Inuences. The scale ranges from 0 (most free) to 100 (least free).
- 4.44.1 rsf_p **Press Freedom Index** The Press Freedom index measures the amount of freedom journalists and the media have in each country and the eorts made by governments to see that press freedom is respected. It does not take

account of all human rights violations, only those that aect press freedom. Neither is it an indicator of the quality of a country's media. Note: With the exception of the year 2012 the index ranges between 0 (total press freedom) and 100 (no press freedom). However for the 2012 data release RSF changed the scale so that negative values can be and indeed are assigned to countries with more press freedom. We have decided leave the data as is.

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- *others*
- resilience - ????
- social equity - how to measure?
    - Population living on less than the median income in countries with a Gini coefficient exceeding 0.35 (Raworth 2012)
    - National level
        - GINI coefficient (e.g. from World Bank, estimates from 1980 to 2013)
        - Income share held by lowest 10 or 20 % quantile (World Bank poverty data, estimates 1980's to 2010's)
            - SI.DST.FRST.10
            - SI.DST.FRST.20
    - Poverty headcount ratio at $5 a day (PPP) or national definition including non-comparable values (% of population) (World Bank poverty data, estimates 1980's to 2010's) * SI.POV.5DAY - Poverty headcount ratio at $5 a day (PPP) (% of population) * SI.POV.NAHC.NC - Poverty headcount ratio at national definition including non-comparable values (% of population)
- gender equality - how to measure? - MDGs
    - Employment gap between women and men in waged work (excluding agriculture) (Raworth 2012)
    - Representation gap between women and men in national parliaments (Raworth 2012)
    - *QoG variables*
        - Inter-Parliamentary Union Data Note: The gures for South Africa on the distribution of seats in the Upper House do not include the 36 special rotating delegates appointed on an ad hoc basis, and all percentages given are therefore calculated on the basis of the 54 permanent seats.
        - 4.36.2 ipu_l_sw **Share of Women (Lower House)** (N=191, 1997-2007). Share of Women (Lower House)
        - 4.9.16 ciri_wopol **Women's Political Rights** (1981-2011). Women's political rights include a number of internationally recognized rights. These rights include The right to vote, The right to run for political o_ce, The right to hold elected and appointed government positions, The right to join political parties, The right to petition government officials. A score of 0 indicates that women's political rights were not guaranteed by law during a given year. A score of 1 indicates that women's political rights were guaranteed in law, but severely prohibited in practice.

A score of 2 indicates that women's political rights were guaranteed in law, but were still moderately prohibited in practice. Finally, a score of 3 indicates that women's political rights were guaranteed in both law and practice.

- 4.9.15 ciri_wecon **Women's Economic Rights** (1981-2011). Women's economic rights include a number of internationally recognized rights. These rights include: Equal pay for equal work, Free choice of profession or employment without the need to obtain a husband or male relative's consent, The right to gainful employment without the need to obtain a husband or male relative's consent, Equality in hiring and promotion practices, Job security (maternity leave, unemployment benefits, no arbitrary hiring or layoffs, etc…), Non-discrimination by employers, The right to be free from sexual harassment in the workplace, The right to work at night, The right to work in occupations classified as dangerous, The right to work in the military and the police force. A score of 0 indicates that there were no economic rights for women in law and that systematic discrimination based on sex may have been built into law. A score of 1 indicates that women had some economic rights under law, but these rights were not effectively enforced. A score of 2 indicates that women had some economic rights under law, and the government effectively enforced these rights in practice while still allowing a low level of discrimination against women in economic matters. Finally, a score of 3 indicates that all or nearly all of women's economic rights were guaranteed by law and the government fully and vigorously enforces these laws in practice.
- 4.9.16 ciri_wopol **Women's Political Rights** (1981-2011). Women's political rights include a number of internationally recognized rights. These rights include: The right to vote, The right to run for political o_ce, The right to hold elected and appointed government positions, The right to join political parties, The right to petition government o_cials. A score of 0 indicates that women's political rights were not guaranteed by law during a given year. A score of 1 indicates that women's political rights were guaranteed in law, but severely prohibited in practice. A score of 2 indicates that women's political rights were guaranteed in law, but were still moderately prohibited in practice. Finally, a score of 3 indicates that women's political rights were guaranteed in both law and practice.
- 4.9.18 ciri_wosoc **Women's Social Rights** (1981-2011). Women's social rights include a number of internationally recognized rights. These rights include: The right to equal inheritance, The right to enter into marriage on a basis of equality with men, The right to travel abroad, The right to obtain a passport, The right to confer citizenship to children or a husband, The right to initiate a divorce, The right to own, acquire, manage, and retain property brought into marriage, The right to participate in social, cultural, and community activities, The right to an education, The freedom to choose a residence/domicile, Freedom from female genital mutilation of children and of adults without their consent, Freedom from forced sterilization. A score of 0 indicates that there were no social rights for women in law and that systematic discrimination based on sex may have been built into law. A score of 1 indicates that women had some social rights under law, but these rights were not e_ectively enforced. A score of 2 indicates that women had some social rights under law, and the government e_ectively enforced these rights in practice while still allowing a low level of discrimination against women in social

matters. Finally, a score of 3 indicates that all or nearly all of women's social rights were guaranteed by law and the government fully and vigorously enforced these laws in practice. Note: This Variable was retired as of 2005.

- governance
    - Sense of personal political efficacy (OXFAM UK report)
        - 59% of people feel they have no say in what the government does (GB 2012)
        - World Bank world wide governance indicators (1996-2013)
            - Voice and Accountability
            - Regulatory Quality
            - Rule of Law
            - Political Stability and Absence of Violence/Terrorism
            - Government Effectiveness
            - Control of Corruption
    - *QoG variables*
        - **The Worldwide Governance Indicators** These indicators are based on several hundred individual variables measuring perceptions of governance, drawn from 31 separate data sources constructed by 25 dierent organizations. These individual measures of governance are assigned to categories capturing key dimensions of governance. An unobserved component model is used to construct six aggregate governance indicators. Point estimates of the dimensions of governance, the margins of error as well as the number of sources are presented for each country. The governance estimates are normally distributed with a mean of zero and a standard deviation of one each year of measurement. This implies that virtually all scores lie between -2.5 and 2.5, with higher scores corresponding to better outcomes. WARNING: Since the estimates are standardized (with a mean of zero and a standard deviation of one) each year of measurement, they are not directly suitable for over-time comparisons within countries. Kaufmann et al. (2006) however nd no systematic time-trends in a selection of indicators that do allow for comparisons over time, which suggests that time-series information in the WBGI scores can be used if interpreted with caution.
        - 4.55.1 wbgi_cce **Control of Corruption - Estimate** (N=193, 1996-2012, mean=0, sd=1). Control of Corruption - Estimate: "Control of Corruption" measures perceptions of corruption, conventionally dened as the exercise of public power for private gain. The particular aspect of corruption measured by the various sources diers somewhat, ranging from the frequency of "additional payments to get things done", to the eects of corruption on the business environment, to measurin "grand corruption" in the political arena or in the tendency of elite forms to engage in "state capture".
        - 4.55.3 wbgi_gee **Government Eectiveness - Estimate** (N=193, 1996-2012, mean=0, sd=1). Government Eectiveness - Estimate: "Government Eectiveness" combines into a single grouping responses on the quality of public service provision, the quality of the bureaucracy, the competence of civil servants, the independence of the civil service from political pressures, and the credibility of the

government's commitment to policies. The main focus of this index is on "inputs" required for the government to be able to produce and implement good policies and deliver public goods.

- 4.55.5 wbgi_pse **Political Stability - Estimate** (N=195, 1996-2012, mean=0, sd=1). Political Stability - Estimate: "Political Stability" combines several indicators which measure perceptions of the likelihood that the government in power will be destabilized or overthrown by possibly unconstitutional and/or violent means, including domestic violence and terrorism.
- 4.55.7 wbgi_rle **Rule of Law - Estimate** (N=195, 1996-2012, mean=0, sd=1). Rule of Law - Estimate: "Rule of Law" includes several indicators which measure the extent to which agents have condence in and abide by the rules of society. These include perceptions of the incidence of crime, the eectiveness and predictability of the judiciary, and the enforceability of contracts. Together, these indicators measure the success of a society in developing an environment in which fair and predictable rules form the basis for economic and social interactions and the extent to which property rights are protected.
- "**Contestation and Inclusiveness, (1950-2000)** These are the two principal components of 13-15 indicators of democracy, including those compiled by Freedom House; Polity; Arthur Banks; Alvarez, Cheibub, Limongi, and Przeworski, as updated by Cheibub and Gandhi; Bollen; and Cingranelli and Richards. The dataset covers most countries in the world from 1950 through 2000. In an article in the Journal of Politics (July 2008), Angel Alvarez, Claudia Maldonado, and I argue that these principal components, which capture 75 percent of variation in the most commonly used democracy indicators, measure Robert Dahl's two dimensions of polyarchy: contestation and inclusiveness. We recommend that scholars use the standardized versions of these components (CONTESTstd and INCLUSstd), which have been adjusted to be comparable from year to year."
    - cam_contest Contestation (standardized version)
    - cam_inclusive Inclusiveness (standardized version)
- 4.9.7 ciri_injud **Independence of the Judiciary** This variable indicates the extent to which the judiciary is independent of control from other sources, such as another branch of the government or the military. A score of 0 indicates "not independent"", a score of 1 indicates"partially independent"" and a score of 2 indicates "generally independent".
- 4.20.4 fh_ipolity2 **Freedom House/Imputed Polity** (N=207, 1972-2012, [0:10]). Scale ranges from 0-10 where 0 is least democratic and 10 most democratic. Average of Freedom House (fh_pr and fh_cl) is transformed to a scale 0-10 and Polity (p_polity2) is transformed to a scale 0-10. These variables are averaged into fh_polity2. The imputed version has imputed values for countries where data on Polity is missing by regressing Polity on the average Freedom House measure. Hadenius & Teorell (2005) show that this average index performs better both in terms of validity and reliability than its constituent parts.
- 4.20.5 fh_polity2 **Freedom House/Polity** (N=179, 1972-2012, [0:10]). Scale ranges from 0-10 where 0 is least democratic and 10 most democratic. Average of Freedom House (fh_pr and fh_cl) is transformed to a scale 0-10 and Polity

(p_polity2) is transformed to a scale 0-10. These variables are averaged into fh_polity2.

- 4.20.6 fh_pr **Political Rights** (N=207, 1972-2012, [0:7]). Political rights enable people to participate freely in the political process, including the right to vote freely for distinct alternatives in legitimate elections, compete for public oce, join political parties and organizations, and elect representatives who have a decisive impact on public policies and are accountable to the electorate. The specic list of rights considered varies over the years. Countries are graded between 1 (most free) and 7 (least free).
- 4.20.7 fh_status **Status** (N=207, 1972-2012, [0:7]). (1) Free. (2) Partly Free. (3) Not Free. Until 2003, countries whose combined average ratings for Political Rights and Civil Liberties fell between 1.0 and 2.5 were designated “Free”“; between 3.0 and 5.5”Partly Free“”, and between 5.5 and 7.0 “Not Free”. Since then, countries whose ratings average 1.0 to 2.5 are considered “Free”“, 3.0 to 5.0”Partly Free“, and 5.5 to 7.0”Not Free“.
- 4.28.2 h_polcon3 **Political Constraints Index III** (N=201, 1946-2012, [0:1]). This index measures the feasibility of policy change, i.e. the extent to which a change in the preferences of any one political actor may lead to a change in government policy. The index is composed from the following information: the number of independent branches of government with veto power over policy change, counting the executive and the presence of an eective lower and upper house in the legislature (more branches leading to more constraint); the extent of party alignment across branches of government, measured as the extent to which the same party or coalition of parties control each branch (decreasing the level of constraint); and the extent of preference heterogeneity within each legislative branch, measured as legislative fractionalization in the relevant house (increasing constraint for aligned executives, decreasing it for opposed executives). The index scores are derived from a simple spatial model and theoretically ranges from 0 to 1, with higher scores indicating more political constraint and thus less feasibility of policy change. Note that the coding reects information as of January 1 in any given year. Henisz (2002) uses this index to demonstrate that political environments that limit the feasibility of policy change are an important determinant of investment in infrastructure.
- 4.33.1 icrg_qog **ICRG Indicator of Quality of Government** (N=147, 1984-2012, [0:1]). The mean value of the ICRG variables “Corruption”“,”Law and Order" and “Bureaucracy Quality”, scaled 0-1. Higher values indicate higher quality of government.
- **Institutional Quality Dataset** More than 30 established institutional indicators can be clustered into three homogeneous groups of formal institutions: legal, political and economic, which capture to a large extent the complete formal institutional environment of a country. The latent qualities of legal, political and economic institutions for every country in the world and for every year are calculated. On this basis, a legal, political and economic World Institutional Quality Ranking are proposed, through which one can follow whether a country is improving or worsening its relative institutional environment. The calculated latent

institutional quality measures can be useful in further panel data applications and add to the usual practice of using simply one or another index of institutional quality to capture the institutional environment.

- 4.38.1 kun_legabs **Absolute legal institutional quality (simple averages)** (N=195, 1990-2010). Absolute legal institutional quality (simple averages).
- 4.38.2 kun_polabs **Absolute political institutional quality (simple averages)** (N=184, 1990-2010) Absolute political institutional quality (simple averages).
- **Unified Democracy Scores** Unied Democracy Scores (UDS), now covering the time period 1946-2012. These new scores incorporate recent updates to three of the ten original measures-Freedom House (2014), Polity IV (Marshall et al. 2012), and VanHanen (2012)-that feature in the analysis that we report in our 2010 article. In addition, the current release adds a recently developed measure of democracy-Economist Intelligence Unit (2012)-to our framework. Using the most current release of the UDS, we have replicated gure 3 from the original article to provide users with a snapshot of the updated scores, focusing on the year 2000.
- 4.49.1 uds_mean **Unified Demo. Score Posterior (Mean)** (N=210, 1946-2012). Unified Demo. Score Posterior (Mean). Higher score, better democracy.
- 4.49.1 uds_median **Unified Demo. Score Posterior (Median)** (N=210, 1946-2012). Unified Demo. Score Posterior (Median). Higher score, better democracy.
- **Measures of Democracy 1810-2012** The data contain three dierent variables, created by Tatu Vanhanen in his long-term research, for each year from 1810 to 2012. The variables in question are political competition, political participation and the index of democratization.
- 4.53.1 van_comp **Competition** (N=200, 1946-2010). The competition variable portrays the electoral success of smaller parties, that is, the percentage of votes gained by the smaller parties in parliamentary and/or presidential elections. The variable is calculated by subtracting from 100 the percentage of votes won by the largest party (the party which wins most votes) in parliamentary elections or by the party of the successful candidate in presidential elections. Depending on their importance, either parliamentary or presidential elections are used in the calculation of the variable, or both elections are used, with weights. If information on the distribution of votes is not available, or if the distribution does not portray the reality accurately, the distribution of parliamentary seats is used instead. If parliament members are elected but political parties are not allowed to take part in elections, it is assumed that one party has taken all votes or seats. In countries where parties are not banned but yet only independent candidates participate in elections, it is assumed that the share of the largest party is not over 30 percent.
- 4.53.2 van_index **Index of Democratization** (N=200, 1946-2010). The index of democratization is formed by multiplying the competition and the participation variables and then dividing the outcome by 100.
- 4.53.3 van_part **Participation** (N=200, 1946-2010). The political participation variable portrays the voting turnout in each election, and is calculated as the percentage of the total population who actually voted in the election. In the case of indirect elections, only votes cast in the nal election are taken into account. If

electors have not been elected by citizens, only the number of actual electors is taken into account, which means that the degree of participation drops to the value 0. If an election to choose electors has been held, the participation variable is calculated from the number and distribution of votes in that election. National referendums raise the variable value by ve percent and state (regional) referendums by one percent for the year they are held. Referendums can add the degree of participation at maximum by 30 percent a year. The value of the combined degree of participation cannot be higher than 70 percent, even in cases where the sum of participation and referendums would be higher than 70.

- connectivity (???household goods???)
    - People who do have not internet connection due to barriers such as affordability and complexity (OXFAM UK report).
    - *QoG variables*
    - 4.56.7 wdi_broadband **Fixed broadband Internet subscribers (per 100 people)** (N=193, 1995-2012). Fixed broadband Internet subscribers are the number of broadband subscribers with a digital subscriber line, cable modem, or other high-speed technology.
    - 4.56.30 wdi_internetuse **Internet users (per 100 people)** (N=193, 1960-2012). Internet users are individuals who have used the Internet (from any location) in the last 12 months. Internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV etc.
    - 4.56.35 wdi_mobile **Mobile cellular subscriptions (per 100 people)** (N=198, 1960-2012). Mobile cellular telephone subscriptions are subscriptions to a public mobile telephone service using cellular technology, which provide access to the public switched telephone network. Post-paid and prepaid subscriptions are included.
- transport
    - No defined / identified (OXFAM UK report)
    - *QoG variables*
        - 4.9.3 ciri_dommov **Freedom of Domestic Movement** (1981-2011) This variable indicates citizens' freedom to travel within their own country. A score of 0 indicates that this freedom was severely restricted, a score of 1 indicates the freedom was somewhat restricted, and a score of 2 indicates unrestricted freedom of foreign movement.
- crime (???safety???)
    - Risk of victimization (OXFAM UK report)
        - 17% of adults were victims of crime within the past 12 months (women 16.7%, men 17.4%) (England and Wales 2013-2014)
- local environment
    - Access to the natural environment once per week (OXFAM UK report)
        - 52% of people access the natural environment less than once per week (England 2013-2014)
- sense of support

    - People lacking satisfying work (UK OXFAM report)
        - 10% of people have little or no support in times of need (UK 2012)
- economic freedoms
    - 4.21.2 _index_cl **Economic Freedom of the World Index (chain-linked)** (N=123, 1970-2010, [0:10]). One problem with the version of the index of economic freedom (_index) is that the underlying data is more complete in recent years than in earlier years. As a result, changes in the index ratings over time may reect the fact that some components are missing in some years but not in others.The problem of missing components threatens the comparability of the index ratings over time. In order to correct for this problem, the Fraser Institute has constructed a chain-linked summary index of economic freedom that is based on the 2000 rating as a base year. Changes to the index going backward (and forward) in time are then based only on changes in components that were present in adjacent years. The chain-linked methodology means that a country's rating will change across time periods only when there is a change in ratings for components present during both of the over-lapping years. This is precisely what one would want when making comparisons across time periods.
    - 4.29.1 hf_corrupt **Freedom from Corruption** (N=183, 1994-2013, [0:10]). This factor relies on Transparency International's Corruption Perceptions Index (CPI), which measures the level of corruption in 152 countries, to determine the freedom from corruption scores of countries that are also listed in the Index of Economic Freedom. The CPI is based on a 10-point scale in which a score of 10 indicates very little corruption and a score of 0 indicates a very corrupt government. In scoring freedom from corruption, the authors convert each of these raw CPI data to a 0-100 scale by multiplying the CPI scores by 10.
    - 4.29.2 hf_escore **Economic Freedom Index** (N=183, 1994-2013, [0:10]). The Economic Freedom index uses 10 specic freedoms, some as composites of even further detailed and quantiable components: Business freedom (hf_business), Trade freedom (hf_trade), Fiscal freedom (hf_scal), Freedom from government (hf_govt), Monetary freedom (hf_monetary), Investment freedom (hf_invest), Financial freedom (hf_nanc), Property rights (hf_prights), Freedom from corruption (hf_corrupt), Labor freedom (hf_labor). Each of these freedoms is weighted equally and turned into an index ranging from 0 to 100, where 100 represents the maximum economic freedom. Although changes in methodology have been undertaken throughout the measurement period, continuous backtracking has been used to maximize comparability over time.
    - 4.29.3 hf_govt **Freedom from Government** (N=182, 1994-2013, [0:100]). Scoring of the freedom from government factor is based on two components: Government expenditure as a percentage of GDP, Revenues generated by state-owned enterprises (SOEs) and property as a percentage of total government revenue. Government expenditure as a percentage of GDP is weighted as two-thirds of the freedom from government factor score, and revenue from SOEs is weighted as one-third. In cases where SOE data does not exist, the data is excluded from the factor score. The country's freedom from government ranges between 0 and 100, where 100 represents the maximum degree of freedom from government.

- 4.29.5 hf_prights **Property Rights** (N=180, 1994-2013, [0:100]). This factor scores the degree to which a country's laws protect private property rights and the degree to which its government enforces those laws. It also accounts for the possibility that private property will be expropriated. In addition, it analyzes the independence of the judiciary, the existence of corruption within the judiciary, and the ability of individuals and businesses to enforce contracts. The less certain the legal protection of property is and the greater the chances of government expropriation of property are, the higher a country's score is. The country's property rights score ranges from 0 and 100, where 100 represents the maximum degree of protection of property rights.
- 4.29.6 hf_trade **Trade Freedom** (N=182, 1994-2013, [0:100]). The trade freedom score is based on two inputs: The trade-weighted average tari rate, Non-tariff barriers (NTBs). Weighted average taris is a purely quantitative measure and accounts for the basic calculation of the score. The presence of NTBs in a country aects its trade freedom score by incurring a penalty of up to 20 percentage points, or one-fth of the maximum score. The country's trade freedom ranges between 0 and 100, where 100 represents the maximum degree of trade freedom.

- peace
  - *QoG variables*
  - UCDP/PRIO Armed Conict Dataset A conict-year dataset with information on armed conict where at least one party is the government of a state in the time period 1946-2013.
  - 4.48.1 ucdp_type1 **Extrasystemic armed conflict** (N=164, 1946-2013). Number of extrasystemic armed conicts per country in a given year. Extrasystemic armed conflict occurs between a state and a non-state group outside its own territory. (In the COW project,extrasystemic war is subdivided into colonial war and imperial war, but this distinction is not used here.) These conicts are by denition territorial, since the government side is ghting to retain control of a territory outside the state system.
  - 4.48.2 ucdp_type2 **Interstate armed conflict** (N=164, 1946-2013). Number of interstate armed conicts per country in a given year. An interstate armed conict occurs between two or more states.
  - 4.48.3 ucdp_type3 **Internal armed conflict** (N=164, 1946-2013). Number of internal armed conics per country in a given year. Internal armed conict occurs between the government of a state and one or moreinternal opposition group(s) without intervention from other states.
  - 4.48.4 ucdp_type4 **Internationalized internal armed conflict** (N=164, 1946-2013). Number of internationalized internal armed conicts per country in a given year. Internationalized internal armed conict occurs between the government of a state and one or more internal opposition group(s) with intervention from other states (secondary parties) on one or both sides.
  - 4.56.4 wdi_armedf **Armed forces personnel, total** (N=175, 1985-2012). Armed forces personnel are active duty military personnel, including paramilitary forces if the training, organization, equipment, and control suggest they may be used to support or replace regular military forces.
  - 4.56.5 wdi_armedfper **Armed forces personnel (% of total labor force)** (N=172, 1990-

2012). Armed forces personnel are active duty military personnel, including paramilitary forces if the training, organization, equipment, and control suggest they may be used to support or replace regular military forces. Labor force comprises all people who meet the International Labour Organization’s denition of the economically active population.

- intellectual capital
    - *QoG variables*
    - 4.56.45 wdi_scitecjournal **Scientic and technical journal articles** (N=191, 1981-2011). Scientic and technical journal articles refer to the number of scientic and engineering articles published in the following elds: physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences.
- technological advancement
    - *QoG variables*
    - 4.56.7 wdi_broadband **Fixed broadband Internet subscribers (per 100 people)** (N=193, 1995-2012). Fixed broadband Internet subscribers are the number of broadband subscribers with a digital subscriber line, cable modem, or other high-speed technology.
    - 4.56.30 wdi_internetuse **Internet users (per 100 people)** (N=193, 1960-2012). Internet users are individuals who have used the Internet (from any location) in the last 12 months. Internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV etc.
    - 4.56.35 wdi_mobile **Mobile cellular subscriptions (per 100 people)** (N=198, 1960-2012). Mobile cellular telephone subscriptions are subscriptions to a public mobile telephone service using cellular technology, which provide access to the public switched telephone network. Post-paid and prepaid subscriptions are included.

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- HDI

1. Life Expectancy Index $LEI = \frac{LE-20}{85-20}$
2. Education Index $EI = \frac{MYSI+EYSI}{2}$

2.1 Mean Years of Schooling Index $MYSI = \frac{MY}{15}$ [6]

2.2 Expected Years of Schooling Index $EYSI = \frac{EYS}{18}$ [7]

3. Income Index $II = \frac{\ln(GNIpc)-\ln(100)}{\ln(75{,}000)-\ln(100)}$

Finally, the HDI is the geometric mean of the previous three normalized indices:
$HDI = \sqrt[3]{LEI * EI * II}$.

LE: Life expectancy at birth MYS: Mean years of schooling (Years that a 25-year-old person or older has spent in schools) EYS: Expected years of schooling (Years that a 5-year-old child will spend with his education in his whole life) GNIpc: Gross national income at purchasing power parity per capita

- **sources for social variables**

- *UK OXFAM REPORT*

- The main sources used for this report are:
- The Impoverishment of the UK (Poverty and Social Exclusion: UK (PSE: UK), led by theUniversity of Bristol);
- Monitoring Poverty and Social Exclusion (Joseph Rowntree Foundation (JRF) and the NewPolicy Institute (NPI));
- The Minimum Income Standard (MIS) (University of Loughborough and JRF);
- ONS Well-being Consultation;
- The Equalities Measurement Framework (Equalities and Human Rights Commission);
- The Oxfam Humankind Index for Scotland (Oxfam).

2.0.11.2 Economic variables

- personal income (median and inequality)
- national - GDP per capita
    - QoG variales
    - 4.56.23 wdi_gdpgr **GDP growth (annual %)** (N=196, 1961-2012). Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2005 U.S. dollars. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.
    - 4.52.1 unna_ah_ GDP: Agriculture, Hunting, Forestry, Fishing (N=201, 1970-2012). GDP: Agriculture, Hunting, Forestry, Fishing
    - 4.52.2 unna_con GDP: Construction (N=202, 1970-2012). GDP: Construction.
    - 4.52.3 unna_gdp Gross Domestic Product (N=202, 1970-2012). Gross Domestic Product
    - 4.52.4 unna_gse GDP: Goods and Services - Export (N=201, 1970-2012). GDP: Goods and Services - Export
    - 4.52.5 unna_gsi GDP: Goods and Services - Import (N=200, 1970-2012). GDP: Goods and Services - Import
    - 4.52.6 unna_man GDP: Manufacturing (N=202, 1970-2012). GDP: Manufacturing
    - 4.52.7 unna_mmu GDP: Mining, Manufacturing, Utilities (N=202, 1970-2012). GDP: Mining, Manufacturing, Utilities
    - 4.52.8 unna_pop Population (N=202, 1970-2012). Population
    - 4.52.9 unna_tsc GDP: Transport, Storage and Communication. GDP: Transport, Storage and Communication
    - 4.52.10 unna_wrrh GDP: Wholesale, Retail Trade, Restaurants and Hotels. GDP: Wholesale, Retail Trade, Restaurants and Hotels

2.0.11.3 Environmental variables

- land use change (resource extraction)
    - Extraction:

        - Use hyde database and satellite images from 2000, 2005, 2010 to look at extraction efficiency. Take into account land use change
    - Consumption:
        - Moran, D., M. Lenzen, K. Kanemoto, A. Geschke (2013) Does ecologically unequal exchange occur? Ecological Economics (89). doi:10.1016/j.ecolecon.2013.02.013 (doi:10.1016/j.ecolecon.2013.02.013)
    - Rain-fed arable land converted to cropland (OXFAM South Africa report)
    - Consumption of land-use change (ha; OXFAM UK report)
        - United Nations Environment Programme (UNEP)-based per capita UK boundary: 0.2 ha/capita. 0.7 ha/capita, exceeding boundary by 250% (UK 2007).
    - *QoG variables*
    - 4.56.22 wdi_forestarea **Forest area (% of land area)** (N=192, 1990-2011). Forest area is land under natural or planted stands of trees of at least 5 meters in situ, whether productive or not, and excludes tree stands in agricultural production systems (for example, in fruit plantations and agroforestry systems) and trees in urban parks and gardens.
    - 4.56.32 wdi_landagr **Agricultural land (% of land area)** (N=195, 1961-2011). Agricultural land refers to the share of land area that is arable, under permanent crops, and under permanent pastures. Arable land includes land dened by the FAO as land under temporary crop (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow. Land abandoned as a result of shifting cultivation is excluded. Land under permanent crops is land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest, such as cocoa, coee, and rubber. This category includes land under owering shrubs, fruit trees, nut trees, and vines, but excludes land under trees grown for wood or timber. Permanent pasture is land used for ve or more years for forage, including natural and cultivated crops.
    - 4.56.33 wdi_landarea **Land area (sq. km)** (N=195, 1961-2011). Land area is a country's total area, excluding area under inland water bodies, national claims to continental shelf, and exclusive economic zones. In most cases the denition of inland water bodies includes major rivers and lakes.

- biodiversity loss
    - Extraction:
        - National biodiversity index - red list index - living planet index
    - Consumption
        - Biodiversity threats embodied in trade (Lenzen et al. 2012).
    - Extinction rate (number of species per million species per year) (Rockstrom et al. 2009)
    - Endangered ecosystems (OXFAM, South Africa report)
    - UK Farmland Birds Index (OXFAM UK report)
    - *effort indicator variables*
    - Protected area (1990-2009)
        - Proportion Marine Protected Areas_TS_2010.xls
        - Proportion Terrestrial Protected Areas_TS_2010.xls

        - ProtectedAreas_Proportion_All.xls
    - *state indicator variables*
    - Forested area
        - ForestTimeSeries_2010.xls
- climate change (resource consumption - not yet measured)
    - Consumption:
    - Consumption of CO2 (MtCO2) (OXFAM UK report)
    - *QoG variables*
    - 4.56.9 wdi_co2mtpc **CO2 emissions (metric tons per capita)** (N=191, 1960-2010). Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas aring.
- freshwater use (resource consumption or extraction)
    - Consumption:
        - Lenzen, M., Moran, D., Bhaduri, A., Kanemoto, K., Bekchanov, M., Geschke, A., Foran, B. (2013) International Trade of Scarce Water. Ecological Economics 94, pp78-85. doi:10.1016/j.ecolecon.2013.06.018 (doi:10.1016/j.ecolecon.2013.06.018)
    - Extraction / DMC
        - Available freshwater consumed (OXFAM, South Africa report)
        - Consumption of freshwater by humans (km3/yr) (OXFAM, South Africa report)
- nitrogen and phosphorous cycles/emission (resource consumption/was)
    - Extraction:
        - Could look at emissions from agriculture and aquaculture.
    - Consumption:
        - Needs to be conducted in an MRIO framework.
    - Amount N2 removed from atmosphere for human use (Mt/yr) (Rockstrom et al. 2009)
    - Nitrogen application rate (OXFAM South Africa report)
    - Phosphorous flowing into oceans (PMt/yr) (Rockstrom et al. 2009)
    - Total P concentration in dams (P mg/l) (OXFAM South Africa report)
    - Phosphorous loads in UK rivers (OXFAM UK report)
        - Poor/bad loads of phosphorous in rivers. 11% of UK river testing sites classified as having poor or bad loads (UK 2013).
    - UNEP variables (2002-2008)
        - *Fertilizer area intensities*
        - Fertilizers_Nitrogen time series_updated.xls
        - Fertilizers_Phosphate time series_updated.xls
        - Fertilizers_Potash time series_updated.xls
- ocean accidification
    - ??? hard to measure due to mixing of ocean and ocean and atmosphere - and what are

the resources consumed ???

- chemical pollution
    - ??? industry emissions - public health - but what are the resources consumed ???
    - Not defined (Rockstrom et al. 2009; South Africa, OXFAM South Africa report)
    - Chemical quality of UK rivers (UK OXFAM report)
        - Failure to achieve classifi-cation of good chemical quality. 20% of rivers fail to achieve good chemical quality (England 2009).
- amospheric aerosol loading
    - ??? industry emissions - but what are the consumed resosurces ???
    - Overall particulate concentration in the atmosphere (Global)
- ozone depletion
    - Ozone concentration (Dobson units) (South Africa, OXFAM South Africa report)
    - Ozone-depleting substances (ODS) (OXFAM UK report)
        - Consumptive use of ODS. Zero emissions of ODS. Boundary not exceeded.
    - Annual consumption of HCFCs (Rockstrom et al. 2009)
    - ??? measure CFC emissions, but what are the resources ???
- Air pollution
    - Annual mean PM10 concentration in ug/m3 (South Africa, OXFAM South Africa report)
    - Particulate concentration (PM10; OXFAM UK report)
    - Overall particulate concentration in the atmosphere (Rockstrom et al. 2009)
- Ocean health
    - % of fish stocks harvested sustainably by UK vessels (UK OXFAM report)

      *100% of fishing classified as sustainably harvested. 64% of UK fish harvested unsustainably (UK 2012).
- Freshwater use
    - Consumption of freshwater by humans (km3/yr) (Rockstrom et al. 2009)

2.0.11.4 Material/energy use variables

- UNEP variables
    - Commercial energy comsumption pere Capita
        - Energy use per capita_c2.xls
- *QoG variables*
    - 4.56.11 wdi_elpowconpc **Electric power consumption (kWh per capita)** (N=137, 1960-2011). Electric power consumption measures the production of power plants and combined heat and power plants less transmission, distribution, and transformation losses and own use by heat and power plants.
    - 4.56.16 wdi_energyimp **Energy imports, net (% of energy use)** (N=137, 1960-2011). Net energy imports are estimated as energy use less production, both measured in oil equivalents. A negative value indicates that the country is a net exporter. Energy use

refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport.

- 4.56.17 wdi_enusektoepc **Energy use (kg of oil equivalent per capita)** (N=169, 1960-2011). Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport.
- 4.56.19 wdi_expfuel **Fuel exports (% of merchandise exports)** (N=186, 1962-2012). Fuels comprise SITC section 3 (mineral fuels).

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3 BEYOND RESOURCE INTENSITY AND PRODUCTIVITY

- which sustainability variables have a high resource elasticity
- which sustainability variables have a high resource elasticity to changes in the consumption balance in imports and exports?
- provide a multi-variate dashboard for resource influence on sustainability variables
- add multi-variate assessment of resource efficiency to suggested environmental and development metrics

4 MAIN RESEARCH QUESTIONS

- what do we use resources for
  - social
    - health
    - well-being
    - culture
      - our relation to the environment
  - economic
  - environmental
- what is the impact of our socio-economic activity on the environment
- what is our relation to to the biosphere

5 LIMITATIONS OF THE MRIO APPROACH

From (Wiedmann et al. 2013)

- “The two data sources used in this work are the global MRIO database Eora and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Global Material Flow Database.”
- “S2.3. Methodological Limitations. Recent advances in global MRIO modeling (2, 12) now provide the means to analyze and monitor the MF of nations more reliably than before. However, the method is not without limitations. MRIO accounts are provided initially in monetary terms rather than physical terms. So-called”price errors" can be introduced where individual transactions occur with a different price (dollars per quantity) than average. Allocation errors can occur due to low sectoral or product resolution. For example, a kilogram of gold included in a broad category of materials (e.g., “ores”) allocated to a broad production sector (e.g., “metals and mining”) will not be traced to its final demand as accurately as if gold were differentiated as a distinct input category and the MRIO used distinguished, more specific “gold,” “precious metals,” or “nonferrous metals” sectors rather than a broad metals and mining sector. In this study, we differentiated 35 types of materials and the MRIO used between 25 and 510 industrial sectors per country (5). For countries with more raw material-producing sectors, the allocation of DE data are therefore more accurate than for countries where fewer such sectors are available. For example, if there is just one “aggregate” extraction sector, a part of the “building stone” material flow might be allocated to the chemical industry because some limestone (which is also extracted by the aggregate"
- “The limited resolution of some national input-output tables also constrains the method’s ability in addressing issues around critical metals and resource security due to the facts that (i) many of the critical metals are”specialty metals," which are use for very specific applications that cannot be easily represented by flows between aggregate sectors/products, and (ii) resource security roblems often arise from the presence of mono- or oligopoly structures within a sector. This is an area where hybrid approaches can be very useful. Here, input-output analysis (IOA) is combined with elements from process-based life cycle assessment (LCA) methods, such as those applied by Schoer et al. (13) in a study of the raw material consumption (RMC) of the European Union (EU). The hybrid method takes advantage of truncation-free enumeration of supply chains via IOA and productspecific detail via LCA (14-16). The current framework provides an important first step toward understanding potential risks associated with the global resource supply chain. More detailed information can be added targeting the hotspots identified through a hybrid approach, where process-specific information and aggregate product-level information are integrated. More general elaborations on the uncertainty of"

6 COMPARISON OF THE MRIO APPROACH TO TMC AND TMR

TMR - Total Material Requirement

TMC - Total Materical Consumption

From (Wiedmann et al. 2013)

- “To calculate TMC and TMR, material intensity factors of imports and exports are derived from simplified life cycle inventories (4, 25). A drawback of this LCA factor method is that”that the ecological rucksack of a good which is passing more than one border in one or different process stages is counted more than one time within the volume" (4). This double-counting problem does not occur inMF calculations based on IOA because DE volumes are merely reallocated from production to consumption in a mutually exclusive and collectively comprehensive way. A further complication of the factor method used in TMC/TMR calculations is that coefficients of indirect material flows of imports and exports are mostly derived from specific production systems, such as Germany or the EU (25).“”

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7 DIFFERENTIATING MSE FROM OTHER FIELDS

- Related to global sustainability studies and sustainability science
- Related to socio-ecology
- Related to macroecology
- Related to macroeconomics

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8 HOW - THE TOOLBOX OF MACRO-SOCIO-ECOLOGY

- Cross-country comparisons
- Linking earth system science to social dimensions
- Development of methods to study teleconnected socio-ecologicla dynamics
- Composite indicators such as Genuine Progress Indicator
- Scenario?

8.1 THE CORE

Is the core of macro-socio-ecology relating resource consumption to social outcomes and environmental impacts?

9 REFERENCES

The following literature was cited

Wiedmann, Thomas O, Heinz Schandl, Manfred Lenzen, Daniel Moran, Sangwon Suh, James West, and Keiichiro Kanemoto. 2013. “The material footprint of nations.” *Proceedings of the National Academy of Sciences of the United States of America*, September. doi:10.1073/pnas.1220362110 (http://dx.doi.org/10.1073/pnas.1220362110).