SAVi Sustainable Asset Valuation

A Database of Infrastructure Externalities:

Estimating the Societal Impacts of Infrastructure Projects

December 2019
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MAVA FONDATION POUR LA NATURE

IISD International Institute for Sustainable Development

What?

IISD has developed a database that compiles available knowledge on the valuation of infrastructure project **externalities, direct costs and climate risks.**

Why?

Designed to support the estimation of financial performance of infrastructure assets.

It includes the value of externalities and climate risks that are typically unaccounted for in conventional project assessments.

It also provides some direct costs of infrastructure.

How?

Data Collection

Literature Review

Data pulled from relevant peer-reviewed journals and case studies

Public Data

Data provided by governments, NGOs or businesses

Infrastructure Types

The database can be used to estimate costs related to transport, energy, water management, material management, building, mining, or nature-based infrastructures

What values does the database include?

Externalities

- Environmental (1,059 rows)
- Social (291 rows)
- Governance (4 rows)

Direct Costs (196 rows)

- Costs of implementation
- Costs related to operation and management

Climate Risk (511 rows)

- Effects of climatic changes on infrastructure
- Linkage to relevant Copernicus datasets

Externalities included

Environmental

Air pollution, climate change impacts, ecosystem services, environmental remediation, water discharge and pollution, and water use and withdrawal

Social

Child labour, community development, customer satisfaction, changes in marketability, health and safety, labor demand, labor opportunity costs, and property value changes

Governance

Bribery and corruption, and vision and monitoring

Direct costs included

Costs Related to Implementing Infrastructure

- Cost per unit of material
- Construction costs
- Maintenance costs
- Land use costs
- etc.

Climate risks included

Impacts of Climate Change on Infrastructure

- Changes in energy demand
- Changes in efficiency/ capacity of infrastructure
- Changes in durability/ performance of infrastructure
- Costs related to adapting/ failing to adapt to climate change

How does the database function?

Ability to Filter By:

- Infrastructure type
- Externality type
- Stage of the project life in which the cost is incurred

Database Structure:

A	B	C	D	E
Externality type	**Subset of externality type**	**Parameter**	**Unit**	**Value**
Air Pollution	Valuation of air emissions- Aircraft, locomotives and marine vessels	pm2.5	USD/ton	2100000
Air Pollution	Valuation of air emissions- Aircraft, locomotives and marine vessels	SO2	USD/ton	77000
Air Pollution	Valuation of air emissions- Aircraft, locomotives and marine vessels	NOx	USD/ton	6200
Air Pollution	Valuation of air emissions- Area sources	pm2.5	USD/ton	280000
Air Pollution	Valuation of air emissions- Area sources	SO2	USD/ton	43000
Air Pollution	Valuation of air emissions- Area sources	NOx	USD/ton	6800
Air Pollution	Valuation of air emissions- Cement kilns	pm2.5	USD/ton	320000
Air Pollution	Valuation of air emissions- Cement kilns	SO2	USD/ton	38000
Air Pollution	Valuation of air emissions- Cement kilns	NOx	USD/ton	4900
Air Pollution	Valuation of air emissions- Cake Ovens	pm2.5	USD/ton	400000
Air Pollution	Valuation of air emissions- Cake Ovens	SO2	USD/ton	45000

Environmental Externalities | Social Externalities | Governance Externalities | Direct Costs | Climate risk | +

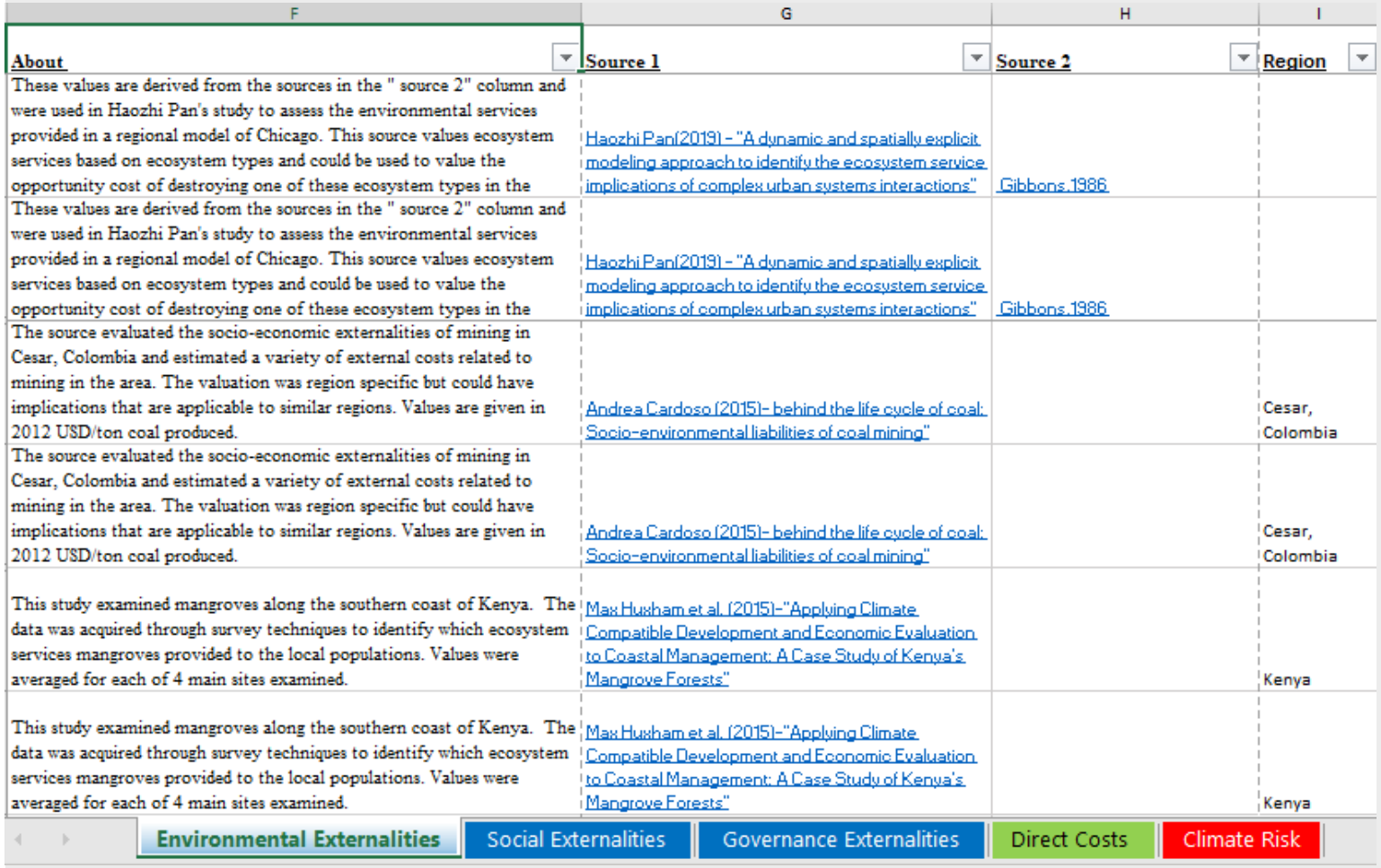
Column A: Identifies externality being evaluated

Column B: Provides supplementary information on externality

Column C: Identifies the parameter

Column D: Identifies the unit and currency

Column E: identifies the corresponding value of the externality



F	G	H	I
About	Source 1	Source 2	Region
These values are derived from the sources in the " source 2" column and were used in Haozhi Pan's study to assess the environmental services provided in a regional model of Chicago. This source values ecosystem services based on ecosystem types and could be used to value the opportunity cost of destroying one of these ecosystem types in the	Haozhi Pan(2019) - "A dynamic and spatially explicit modeling approach to identify the ecosystem service implications of complex urban systems interactions"	Gibbons,1986	
These values are derived from the sources in the " source 2" column and were used in Haozhi Pan's study to assess the environmental services provided in a regional model of Chicago. This source values ecosystem services based on ecosystem types and could be used to value the opportunity cost of destroying one of these ecosystem types in the	Haozhi Pan(2019) - "A dynamic and spatially explicit modeling approach to identify the ecosystem service implications of complex urban systems interactions"	Gibbons,1986	
The source evaluated the socio-economic externalities of mining in Cesar, Colombia and estimated a variety of external costs related to mining in the area. The valuation was region specific but could have implications that are applicable to similar regions. Values are given in 2012 USD/ton coal produced.	Andrea Cardoso (2015)- behind the life cycle of coal: Socio-environmental liabilities of coal mining"		Cesar, Colombia
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This study examined mangroves along the southern coast of Kenya. The data was acquired through survey techniques to identify which ecosystem services mangroves provided to the local populations. Values were averaged for each of 4 main sites examined.	Max Huxham et al. (2015)-"Applying Climate Compatible Development and Economic Evaluation to Coastal Management: A Case Study of Kenya's Mangrove Forests"		Kenya
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Environmental Externalities | Social Externalities | Governance Externalities | Direct Costs | Climate Risk

Column F:

Information about the source, the value and how the value was obtained

Columns G and H:

Linked sources

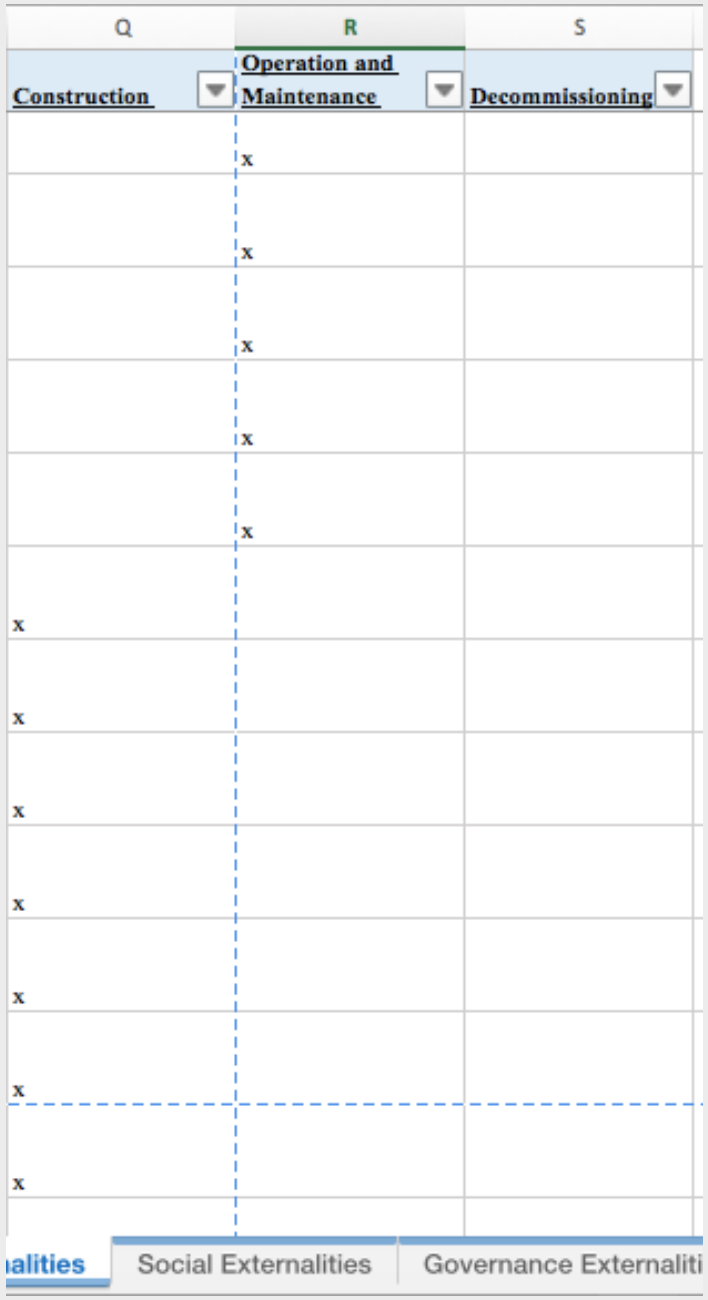
Column I:

Region (if value or case study are region-specific)

Columns J-P: Indicate which infrastructure type is impacted

J	K	L	M	N	O	P
Transport Infrastructure	Energy Infrastructure	Natural Infrastructure	Water Management	Buildings	Materials Management	Mining
	x					x
	x					x
		x				
		x				
		x				
		x				
		x				

Environmental Externalities | Social Externalities | Governance Externalities | ...



Q	R	S
Construction	Operation and Maintenance	Decommissioning
	x	
	x	
	x	
	x	
	x	
x		
x		
x		
x		
x		
x		
x		

alities | Social Externalities | Governance Externaliti

Columns Q-S:

Indicate in which part of the infrastructure project's life the cost is incurred:

- Construction
- Operation and management
- Decommissioning

Within Climate Risk Tab:

Q	R	S	T	U
Emission Scenario	Relevant to Copernicus	Copernicus dataset	Values	Units
RCF 8.5 (wet)	x	Water quantity indicators for Europe	(Unregulated River Flow) Volume rate of water flow that is transported through a given cross-sectional area	m^3/s (% change for future)
RCF 8.5(normal)	x	Water quantity indicators for Europe	(Unregulated River Flow) Volume rate of water flow that is transported through a given cross-sectional area	m^3/s (% change for future)
RCP 4.5	x	CORDEX regional climate model data on single levels for Europe	(10m Wind Speed) The magnitude of the two-dimensional horizontal air velocity. The data represents the mean over the aggregation period near to the surface.	m/s
RCP 4.5	x	CORDEX regional climate model data on single levels for Europe	(10m Wind Speed) The magnitude of the two-dimensional horizontal air velocity. The data represents the mean over the aggregation period near to the surface.	m/s

Environmental Externalities | Social Externalities | Governance Externalities | Direct Costs | Climate Risk

Column Q:

Emissions scenario corresponding to value

Column R:

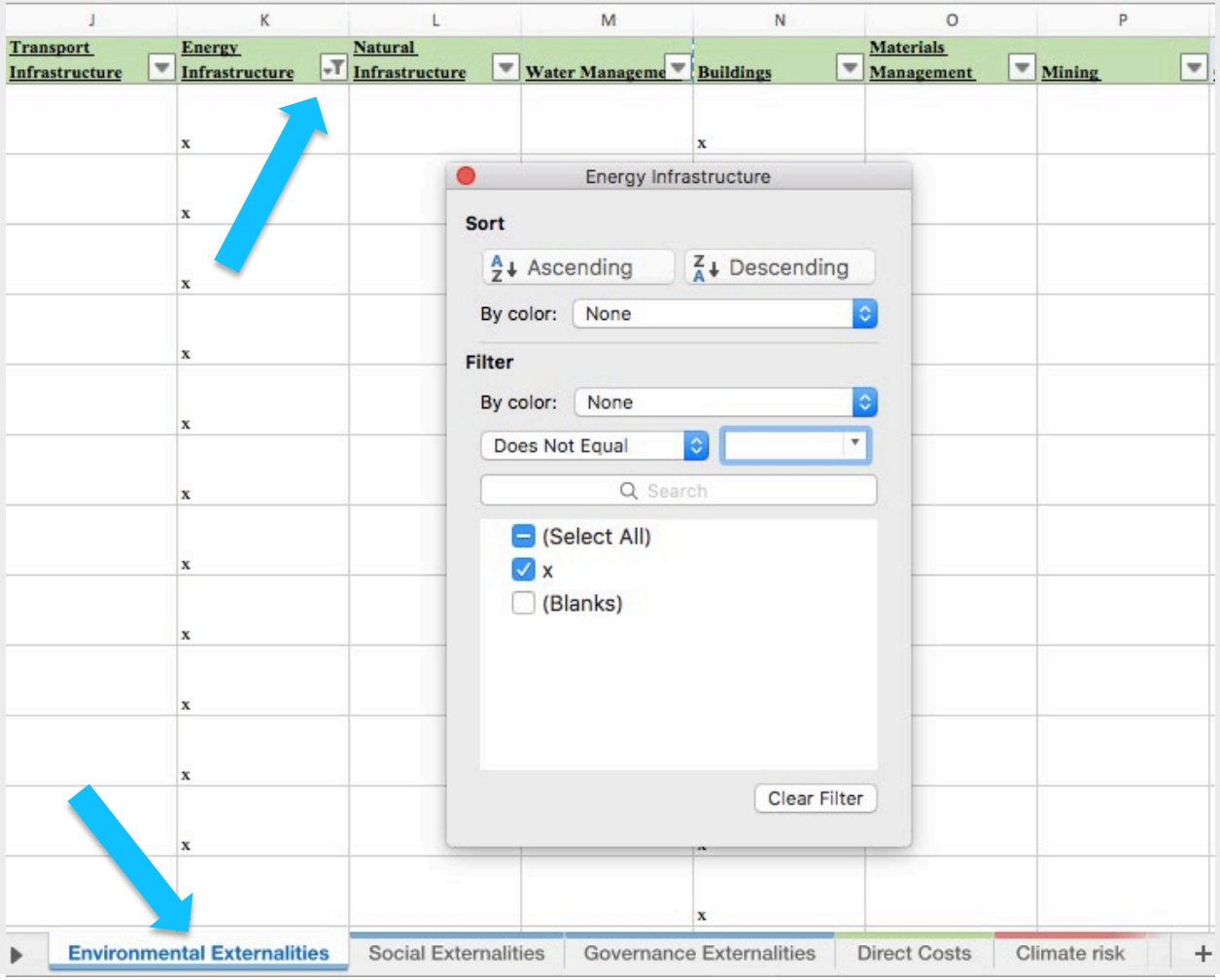
Identifies if the value can be linked to a Copernicus dataset

Column S-U:

The title of the relevant Copernicus dataset, the values that correspond and the units associated with these values.

Example of Database's Application

Scenario: Comparing Wind Energy and Coal-Powered Energy Sources



(i) Select tab related to externality type:

e.g. Environmental

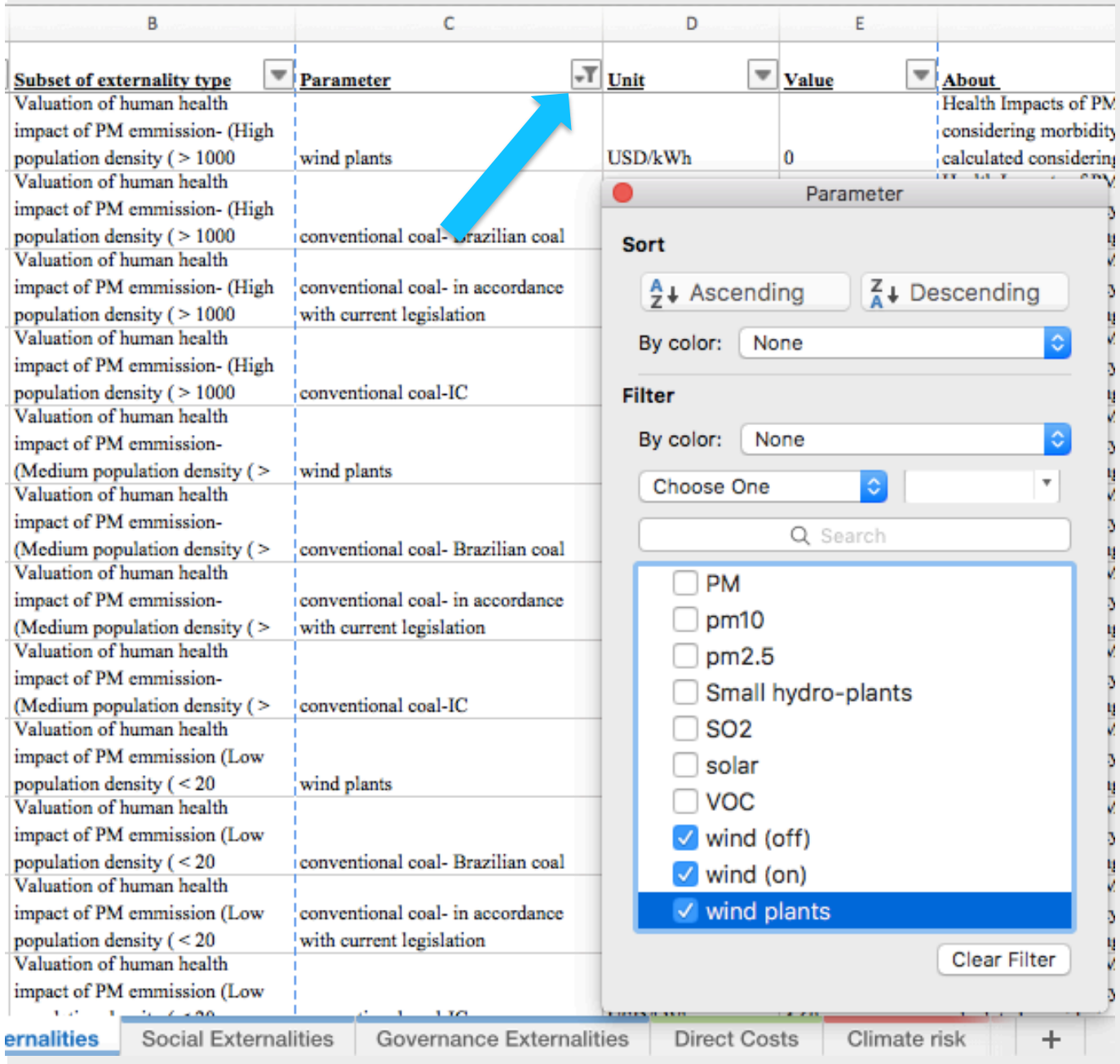
(ii) Filter by infrastructure type (Columns J-P):

e.g. energy infrastructure

A	B	C	D	E
Externality type	**Subset of externality type**	**Parameter**	**Unit**	**Value**
Air Pollution	Valuation of air emissions-Aircraft, locomotives and marine vessels	pm2.5	USD/ton	2100000
Air Pollution	Valuation of air emissions-Aircraft, locomotives and marine vessels	SO2	USD/ton	77000
Air Pollution	Valuation of air emissions-Aircraft, locomotives and marine vessels	NOx	USD/ton	6200
Air Pollution	Valuation of air emissions- Area sources	pm2.5	USD/ton	280000
Air Pollution	Valuation of air emissions- Area sources	SO2	USD/ton	43000
Air Pollution	Valuation of air emissions- Area sources	NOx	USD/ton	6800

(iii) Filter by externality type that is of interest (Column A):

e.g. air pollution



(iv) Filter further by parameter to obtain relevant values (Column C):

e.g. parameters relevant to wind and coal power generation

The database yields relevant information from two sources:

A	B	C	D	E
Externality type	**Subset of externality type**	**Parameter**	**Unit**	**Value**
Air Pollution	Valuation of human health impact of PM emissions- (High population density (> 1000 inhabitants/ km^2))	combined cycle natural gas	USD/kWh	0
Air Pollution	Valuation of human health impact of PM emissions- (High population density (> 1000 inhabitants/ km^2))	nuclear plants	USD/kWh	0
Air Pollution	Valuation of human health impact of PM emissions- (High population density (> 1000 inhabitants/ km^2))	conventional coal- Brazilian coal	USD/kWh	2106.95
Air Pollution	Valuation of human health impact of PM emissions- (High population density (> 1000 inhabitants/ km^2))	conventional coal- in accordance with current legislation	USD/kWh	12.65
Air Pollution	Valuation of human health impact of PM emissions- (High population density (> 1000 inhabitants/ km^2))	conventional coal-Imported coal	USD/kWh	233.08
Air Pollution	Valuation of human health impact of PM emissions- (Medium population density (> 100 inhabitants/ km^2))	conventional coal- Brazilian coal	USD/kWh	210.69
Air Pollution	Valuation of human health impact of PM emissions- (Medium population density (> 100 inhabitants/ km^2))	conventional coal- in accordance with current legislation	USD/kWh	1.265
Air Pollution	Valuation of human health impact of PM emissions- (Medium population density (> 100 inhabitants/ km^2))	conventional coal-Imported coal	USD/kWh	23.31
Air Pollution	Valuation of human health impact of PM emissions (Low population density (< 20 inhabitants/ km^2))	conventional coal- Brazilian coal	USD/kWh	42.15

Environmental Externalities | Social Externalities | Governance Externalities | Direct Costs | Climate Risk

Health impacts from particle emissions based on population density

Cost due to carbon emissions over the lifecycle of each plant (based on carbon tax value)

Externality type	Subset of externality type	Parameter	Unit	Value
Air Pollution	Valuation of carbon emissions by energy type- life cycle costs	wind (off)	USD/plant	654.836
Air Pollution	Valuation of carbon emissions by energy type- life cycle costs	Coal	USD/plant	55510.715/33
Air Pollution	Valuation of carbon emissions by energy type- life cycle costs	wind (on)	USD/plant	1049.074

Similarly, filtering in climate risk tab with respect to wind generation and coal generation yields information on plant performance changes due to climatic changes:

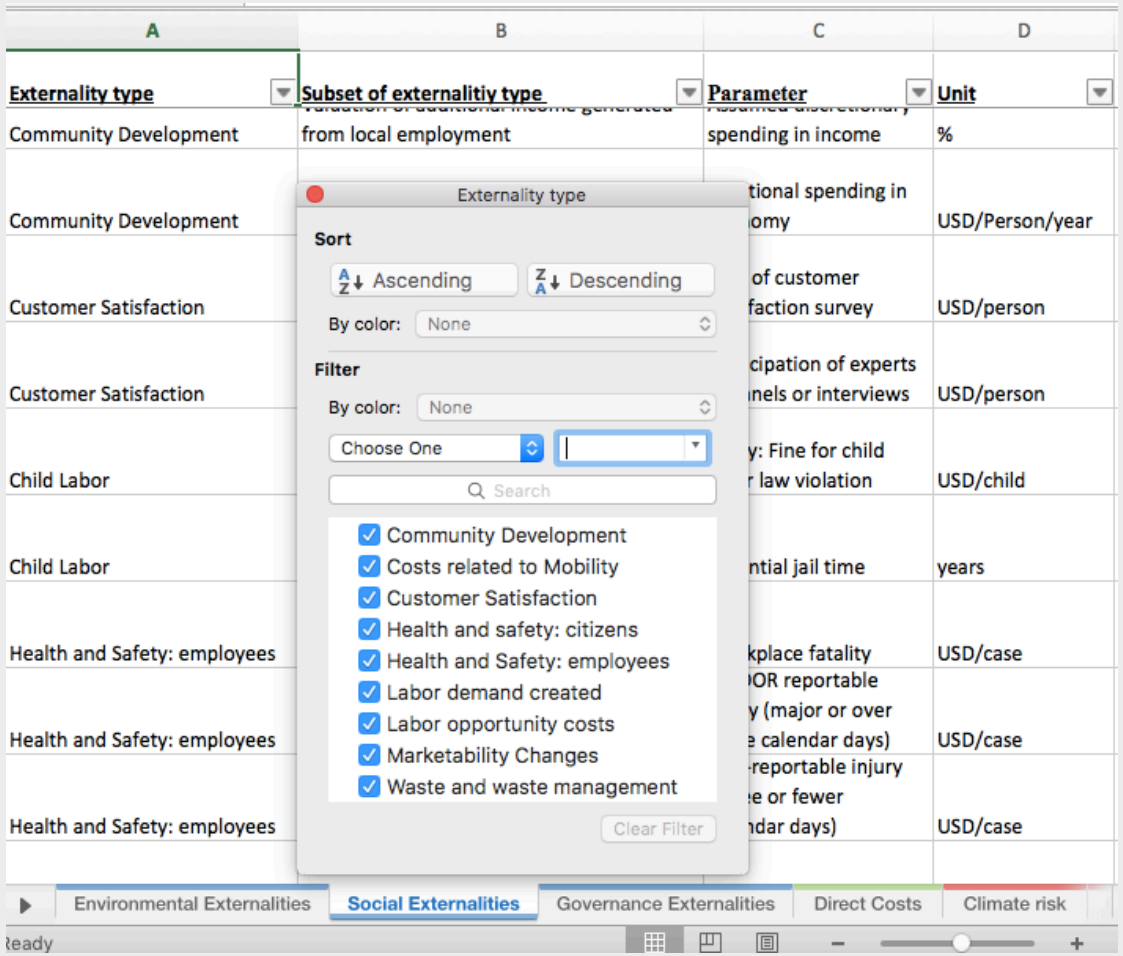
A	B	C	D	E	F	G	H	I
Externality Type	**Externality Info**	**Parameter**	**Unit**	**Value**	**About**	**Source**	**Source 2**	**Region**
Energy generation	Thermal power	gas and coal power plant	%/1 degree C increase in temp of environment	0.8	cooling water temperature on the thermal efficiency of nuclear power plants" was	Torben K. Mideksa and Steffen Kallbekken (2009)- "The impact of climate change on the electricity market: A review"		Baltic region
Energy generation		Wind power	% production decline/ 10% decrease wind speed	12	Rayleigh wind speed distribution. Sample 3MW wind turbine and Pelamis wave	Harrison and Wallace (2005)- "Climate Sensitivity of Marine Energy"	Jennifer Cronin, Gabrial Anandarajah,	

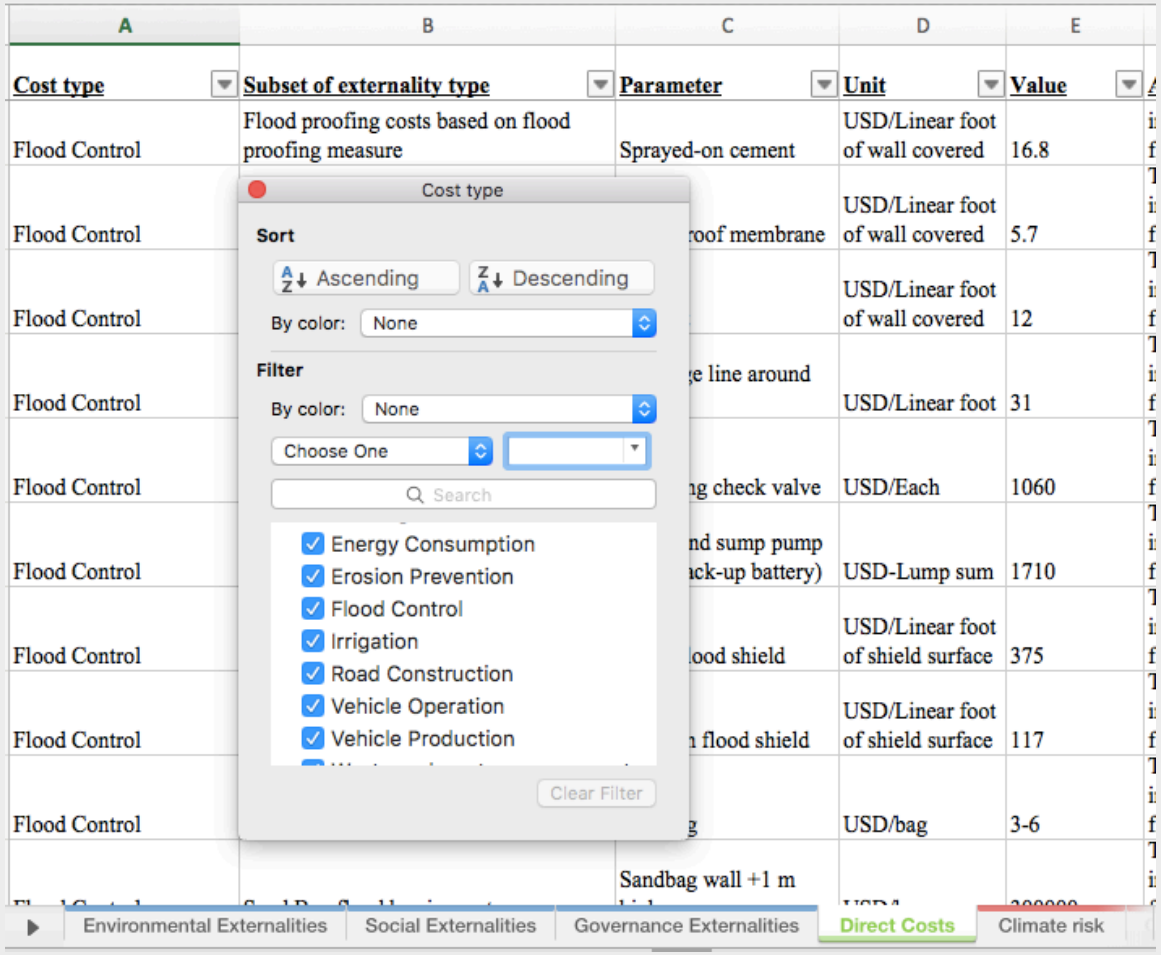
The relevant Copernicus dataset is identified in Column S (corresponding values and units in Columns T and U)

Q	R	S	T	U
Emission Scenario	**Relevant to Copernicus**	**Copernicus dataset**	**Values**	**Units**
	x	CMIP5 daily data on pressure levels	(air temperature): the temperature of the air	K
	x	CMIP5 monthly data on single levels/ CORDEX regional climate model data on single levels for Europe	(10 m wind_Speed) Magnitude of the two-dimensional horizontal air velocity near thesurface.	m/s

Similar strategies can be employed for other externality types, direct costs or infrastructure project types

Examples of social externalities and direct costs:





Thank You!