

Background Paper prepared for the Global Assessment Report on
Disaster Risk Reduction 2013

Approximate Model for Worldwide Building Stock

in Three Size Categories of Settlements

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World Agency of Planetary Monitoring & Earthquake
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Summary

The purpose of this project was to model the world population distribution into building types in three size categories of settlements: major urban, minor urban, and rural. With this dataset, losses may be calculated for the population dataset with approximately 2 million settlements contained in WAPMERR's QLARM program, or for the LANDSCAN population data defined in populated polygons. Because no detailed information on building stock exists for many countries, we had to model their built environment by using data from neighboring countries, which can be reasonably assumed to have similar properties. Because previous groupings of countries were not realistic in all choices, we introduced new groupings. The sources for building types were: 40% from census data, 25% from the WHE/PAGER project, 25% based on research, 9% based on UN reports, and 1% on HAZUS data. For modeling the built environment separately in three settlement classes, we followed Satterthwaithe and used 2,000 and 20,000 people as limits for all countries. For the smallest and largest categories of settlements, we use the distributions of people into PAGER construction types. The distribution of people in the intermediate size settlements is calculated as average from the largest and smallest categories. A comparison of the population estimated to be affected by a recent M6.8 earthquake in Myanmar showed that the LANDSCAN urban polygon data contain only half of the population known to be present, based on QLARM data. A report on the origin of building and occupancy data for individual countries is provided under separate cover as Appendix A, and the data themselves are contained in an attached excel-file as Appendix B.

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Data Sources

Population: The approximately 2 million settlements we have in the database of our earthquake loss estimating program QLARM will form the basis for the distribution of the population. The sources of population numbers are documented in one-page reports for each country in QLARM. The data themselves can be viewed in QLARM and by a click on the appropriate link one can open the report detailing the sources for the country in question.

Censuses were used when they were available. The population was then increased from the year of the census to the year 2010, applying the growth rate, as given on the web site of the CIA (The World Factbook), uniformly to all settlements. Often census data are not given in detail down to the smallest settlements. In these cases, and when no census was available, we used as a first supplemental source the World Gazetteer, which also lists only the larger settlements. When the sum of the population contained in the census and Gazetteer data did not equal the country's population as given by the CIA, then we extracted from Geonames and the National Geospatial Intelligence Agency (NGA) additional settlement names and their coordinates. For some countries, we supplemented the data by information contained in the loss calculation program preceding QLARM, named QUAKELOSS, which had been constructed by the WAPMERR office in Moscow in 2003. Because Geonames and NGA do not give the population present in their locations, we distributed evenly the population missing in the census plus Gazetteer data. As a result, the sum of the population in QLARM for each country equals the CIA estimate to within about 3%. In the coming year, we will update the QLARM data set on population from the year 2010 to 2013.

The models for the building stock depend on the size of the settlements because villages and cities contain different building types. Although it would be desirable to design size categories specific for each country, there is not enough information available to reliably define detailed limits, at present. Thus, we follow Satterthwaithe (2006) and set the limits in all countries at 2,000 and 20,000 to separate small, medium, and large settlements.

Building Stock: The sources for building stock include the World Housing Encyclopedia (WHE), PAGER, QLARM, publications, reports, photographs from Google Earth and expert opinion.

The quality and detail of information on the built environment varies greatly between countries. For this reason, neighboring countries with similar characteristics of the built environment were grouped. We attempted to assign to each group a reference country for which the building stock is known relatively well, and then assume that the neighbors have the same building stock distribution. This approach is necessary at this stage, where few detailed studies for specific countries are available.

For calculating losses to the built environment due to disasters, one needs a model for the distribution of buildings into types present in all settlements affected by the disaster.

However, for estimating human losses, one needs to know the distribution of people into buildings of different vulnerability classes. The mapping of these different, but similar, data sets into each other is part of this project.

More information on building stock is being developed in all parts of the world, but at the present it is necessary to make approximations. Therefore, we view the database we are constructing here as a first order approximation, based on which more detailed models can be built as more data become available and we expect that in the future countries will be subdivided into sub-regions of different building stock.

Countries included in the report

This report includes data on 242 countries of the world. Uninhabited islands are not included. The countries are grouped by region and sub-regions with a reference country for which data are available as shown in Table 1.

Table 1: List of countries covered by the report.

#	ISO-3	COUNTRY NAME	REGION	REFERENCE COUNTRY	SOURCE	YEAR
1	AFG	Afghanistan	ASIA	Iran	Census	2005
2	ALB	Albania	EUROPE	Albania	WHE	2007
3	DZA	Algeria	AFRICA	Algeria	WHE	2007
4	ASM	American Samoa	OCEANIA	American Samoa	Census	2011
5	AND	Andorra	EUROPE	Spain	WHE	2007
6	AGO	Angola	AFRICA	Gabon	Research	2009
7	AIA	Anguilla	CARIBBEAN	Anguilla	Census	2001
8	ATG	Antigua and Barbuda	CARIBBEAN	Antigua and Barbuda	Census	2001
9	ARG	Argentina	S-AMERICA	Argentina	WHE	2009
10	ARM	Armenia	ASIA	Armenia	Research	2007
11	ABW	Aruba	CARIBBEAN	Netherlands Antilles	Census	2001
12	AUS	Australia	OCEANIA	Australia	Research	2011
13	AUT	Austria	EUROPE	Switzerland	WHE	2007
14	AZE	Azerbaijan	ASIA	Armenia	Research	2007
15	BHS	Bahamas	CARIBBEAN	Bahamas	Census	2000
16	BHR	Bahrain	ASIA	Bahrain	Census	2010
17	BGD	Bangladesh	ASIA	Bangladesh	Research	2007
18	BRB	Barbados	CARIBBEAN	Barbados	Census	2000
19	BLR	Belarus	EUROPE	Hungary	Census	2009
20	BEL	Belgium	EUROPE	Netherlands	Research	2007

#	ISO-3	COUNTRY NAME	REGION	REFERENCE COUNTRY	SOURCE	YEAR
21	BLZ	Belize	CARIBBEAN	Belize	Census	2001
22	BEN	Benin	AFRICA	Benin	Census	2001
23	BMU	Bermuda	CARIBBEAN	Bermuda	Research	2010
24	BTN	Bhutan	ASIA	India	WHE	2007
25	BOL	Bolivia	S-AMERICA	Bolivia	UN	2004
26	BIH	Bosnia and Herzegovina	EUROPE	Macedonia	WHE	2007
27	BWA	Botswana	AFRICA	Botswana	Research	2006
28	BRA	Brazil	S-AMERICA	Brazil	UN	1996
29	IOT	British Indian Ocean Territory	INDIAN OCEAN	Brit. Ind. Ocean Terr.	Research	2012
30	BRN	Brunei Darussalam	ASIA	Philippines	Census	2000
31	BGR	Bulgaria	EUROPE	Bulgaria	Census	2005
32	BFA	Burkina Faso	AFRICA	Burkina Faso	Census	2006
33	BDI	Burundi	AFRICA	Rwanda	Census	2002
34	KHM	Cambodia	ASIA	Burma	Research	2011
35	CMR	Cameroon	AFRICA	Cameroon	Research	2009
36	CAN	Canada	N-AMERICA	United States	HAZUS	2002
37	CPV	Cape Verde	AFRICA	Senegal	Census	2002
38	CYM	Cayman Islands	CARIBBEAN	Belize	Census	2001
39	CAF	Central African Republic of	AFRICA	Cameroon	Research	2009
40	TCD	Chad	AFRICA	Niger	Census	2001
41	CHL	Chile	S-AMERICA	Chile	WHE	2007
42	CHN	China	ASIA	China	WHE	2007
43	CXR	Christmas Island	INDIAN OCEAN	Cocos Islands	UN	1993
44	CCK	Cocos (Keeling) Islands	INDIAN OCEAN	Cocos Islands	UN	1993
45	COL	Colombia	S-AMERICA	Colombia	WHE	2007
46	COM	Comoros	INDIAN OCEAN	Comoros	Research	2000
47	COG	Congo	AFRICA	Gabon	Research	2009
48	COD	Congo, Democratic Republic of	AFRICA	Gabon	Research	2009
49	COK	Cook Islands	OCEANIA	Tuvalu	Census	2002
50	CRI	Costa Rica	C-AMERICA	Nicaragua	UN	2001
51	CIV	Cote d'Ivoire	AFRICA	Ghana	Research	2010
52	HRV	Croatia	EUROPE	Slovenia	WHE	2007
53	CUB	Cuba	C-AMERICA	Cuba	UN	1981

#	ISO-3	COUNTRY NAME	REGION	REFERENCE COUNTRY	SOURCE	YEAR
54	CYP	Cyprus	EUROPE	Cyprus	WHE	2007
55	CZE	Czech Republic	EUROPE	Hungary	Census	2001
56	DNK	Denmark	EUROPE	Norway	Research	2005
57	DJI	Djibouti	AFRICA	Ethiopia	Census	2007
58	DMA	Dominica	CARIBBEAN	Dominica	Census	2001
59	DOM	Dominican Republic	CARIBBEAN	Dominican Republic	Census	2010
60	ECU	Ecuador	S-AMERICA	Peru	WHE	2007
61	EGY	Egypt	AFRICA	Egypt	Research	2009
62	SLV	El Salvador	C-AMERICA	El Salvador	Census	1990
63	GNQ	Equatorial Guinea	AFRICA	Cameroon	Research	2009
64	ERI	Eritrea	AFRICA	Ethiopia	Census	2007
65	EST	Estonia	EUROPE	Lithuania	Census	2001
66	ETH	Ethiopia	AFRICA	Ethiopia	Census	2007
67	FLK	Falkland Islands (Malvinas)	ATLANTIC	Falkland Islands	Research	2010
68	FJI	Fiji	OCEANIA	Fiji	Census	1996
69	FIN	Finland	EUROPE	Norway	Research	2005
70	FRA	France	EUROPE	Switzerland	WHE	2007
71	GUF	French Guiana	S-AMERICA	Guyana	UN	1980
72	PYF	French Polynesia	OCEANIA	French Polynesia	Census	2007
73	ATF	French Southern Territories	INDIAN OCEAN	French Southern Territories	Research	2012
74	GAB	Gabon	AFRICA	Gabon	Research	2009
75	GMB	Gambia	AFRICA	Senegal	Census	2002
76	GEO	Georgia	ASIA	Georgia	WHE	2009
77	DEU	Germany	EUROPE	Switzerland	WHE	2007
78	GHA	Ghana	AFRICA	Ghana	Research	2010
79	GIB	Gibraltar	EUROPE	United Kingdom	WHE	2007
80	GRC	Greece	EUROPE	Greece	WHE	2007
81	GRL	Greenland	EUROPE	Greenland	Research	2009
82	GRD	Grenada	CARIBBEAN	Grenada	Census	2001
83	GLP	Guadeloupe	CARIBBEAN	Guadeloupe	Research	2009
84	GUM	Guam	OCEANIA	Guam	Census	2000
85	GTM	Guatemala	C-AMERICA	Guatemala	UN	1998
86	GGY	Guernsey	EUROPE	United Kingdom	WHE	2007
87	GIN	Guinea	AFRICA	Senegal	Census	2002

#	ISO-3	COUNTRY NAME	REGION	REFERENCE COUNTRY	SOURCE	YEAR
88	GNB	Guinea-Bissau	AFRICA	Senegal	Census	2002
89	GUY	Guyana	S-AMERICA	Guyana	UN	1980
90	HTI	Haiti	CARIBBEAN	Haiti	Census	2003
91	VAT	Holy See (Vatican City State)	EUROPE	Italy	WHE	2007
92	HND	Honduras	C-AMERICA	Honduras	UN	2005
93	HKG	Hong Kong	ASIA	Taiwan	WHE	2009
94	HUN	Hungary	EUROPE	Hungary	Census	2001
95	ISL	Iceland	EUROPE	Norway	Research	2005
96	IND	India	ASIA	India	WHE	2007
97	IDN	Indonesia	ASIA	Indonesia	WHE	2007
98	IRN	Iran, Islamic Republic of	ASIA	Iran	Census	2005
99	IRQ	Iraq	ASIA	Iraq	Research	2004
100	IRL	Ireland	EUROPE	Ireland	WHE	2007
101	IMN	Isle of Man	EUROPE	United Kingdom	WHE	2007
102	ISR	Israel	ASIA	Israel	Research	2010
103	ITA	Italy	EUROPE	Italy	WHE	2007
104	JAM	Jamaica	CARIBBEAN	Jamaica	Census	2001
105	JPN	Japan	ASIA	Japan	WHE	2007
106	JEY	Jersey	EUROPE	United Kingdom	WHE	2007
107	JOR	Jordan	ASIA	Jordan	Census	2004
108	KAZ	Kazakhstan	ASIA	Kyrgyzstan	WHE	2007
109	KEN	Kenya	AFRICA	Kenya	Census	2009
110	KIR	Kiribati	OCEANIA	Vanuatu	UN	1993
111	PRK	Korea, Dem. People's Republic	ASIA	China	WHE	2007
112	KOR	Korea, Republic of	ASIA	Japan	WHE	2007
113	KWT	Kuwait	ASIA	Saudi Arabia	Research	2004
114	KGZ	Kyrgyzstan	ASIA	Kyrgyzstan	WHE	2007
115	LAO	Lao People's Dem. Republic	ASIA	Burma	Research	2011
116	LVA	Latvia	EUROPE	Lithuania	Census	2001
117	LBN	Lebanon	ASIA	Syria	Research	2004
118	LSO	Lesotho	AFRICA	Lesotho	Census	2006
119	LBR	Liberia	AFRICA	Liberia	Census	2008
120	LYB	Libyan Arab Jamahiriya	AFRICA	Algeria	WHE	2007

#	ISO-3	COUNTRY NAME	REGION	REFERENCE COUNTRY	SOURCE	YEAR
121	LIE	Liechtenstein	EUROPE	Switzerland	WHE	2007
122	LTU	Lithuania	EUROPE	Lithuania	Census	2001
123	LUX	Luxembourg	EUROPE	Netherlands	Research	2007
124	MAC	Macao	ASIA	Taiwan	WHE	2009
125	MKD	Macedonia, FYRO.	EUROPE	Macedonia	WHE	2007
126	MDG	Madagascar	AFRICA	Madagascar	Research	2010
127	MWI	Malawi	AFRICA	Malawi	Census	2008
128	MYS	Malaysia	ASIA	Philippines	Census	2000
129	MDV	Maldives	INDIAN OCEAN	Maldives	Census	2006
130	MLI	Mali	AFRICA	Mali	Census	2009
131	MLT	Malta	EUROPE	Italy	WHE	2007
132	MHL	Marshall Islands	OCEANIA	Fiji	Census	1996
133	MTQ	Martinique	CARIBBEAN	Guadeloupe	Research	2009
134	MRT	Mauritania	AFRICA	Morocco	Research	2009
135	MUS	Mauritius	INDIAN OCEAN	Mauritius	Census	2011
136	MYT	Mayotte	INDIAN OCEAN	Mayotte	Census	2007
137	MEX	Mexico	C-AMERICA	Mexico	WHE	2007
138	FSM	Micronesia, Fed. States of	OCEANIA	Micronesia	Census	2002
139	MDA	Moldova, Republic of	EUROPE	Republic of Moldova	UN	2005
140	MCO	Monaco	EUROPE	Italy	WHE	2007
141	MNG	Mongolia	ASIA	Mongolia	WHE	2007
142	MNE	Montenegro	EUROPE	Macedonia	WHE	2007
143	MSR	Montserrat	CARIBBEAN	Montserrat	Census	2001
144	MAR	Morocco	AFRICA	Morocco	Research	2009
145	MOZ	Mozambique	AFRICA	Mozambique	Census	2007
	¹⁴⁶ MMR	Myanmar	ASIA	Myanmar	Research	2011
147	NAM	Namibia	AFRICA	Botswana	Research	2006
148	NRU	Nauru	OCEANIA	Palau	Census	2005
149	NPL	Nepal	ASIA	Nepal	WHE	2007
150	NLD	Netherlands	EUROPE	Netherlands	Research	2007
151	ANT	Netherlands Antilles	CARIBBEAN	Netherlands Antilles	Census	2001
152	NCL	New Caledonia	OCEANIA	Vanuatu	UN	1993
153	NZL	New Zealand	OCEANIA	New Zealand	Research	2012
154	NIC	Nicaragua	C-AMERICA	Nicaragua	UN	2001

#	ISO-3	COUNTRY NAME	REGION	REFERENCE COUNTRY	SOURCE	YEAR
155	NER	Niger	AFRICA	Niger	Census	2001
156	NGA	Nigeria	AFRICA	Nigeria	Research	2006
157	NIU	Niue	OCEANIA	Tonga	Census	2006
158	NFK	Norfolk Island	OCEANIA	Norfolk Island	Census	2011
159	MNP	Northern Mariana Islands	OCEANIA	Northern Mariana Islands	Research	2007
160	NOR	Norway	EUROPE	Norway	Research	2005
161	OMN	Oman	ASIA	Saudi Arabia	Research	2004
162	PAK	Pakistan	ASIA	Pakistan	Research	2008
163	PLW	Palau	OCEANIA	Palau	Census	2005
164	PSE	Palestinian Territory, Occupied	ASIA	Jordan	Census	2004
165	PAN	Panama	C-AMERICA	Nicaragua	UN	2001
166	PNG	Papua New Guinea	OCEANIA	Indonesia	WHE	2007
167	PRY	Paraguay	S-AMERICA	Uruguay	UN	1996
168	PER	Peru	S-AMERICA	Peru	WHE	2007
169	PHL	Philippines	ASIA	Philippines	Census	2000
170	PCN	Pitcairn	OCEANIA	Palau	Census	2005
171	POL	Poland	EUROPE	Hungary	Census	2001
172	PRT	Portugal	EUROPE	Spain	WHE	2007
173	PRI	Puerto Rico	CARIBBEAN	Dominican Republic	Census	2010
174	QAT	Qatar	ASIA	Bahrain	Census	2010
175	REU	Reunion	INDIAN OCEAN	Mauritius	Census	2011
176	ROU	Romania	EUROPE	Romania	WHE	2009
177	RUS	Russian Federation	ASIA	Russia	WHE	2007
178	RWA	Rwanda	AFRICA	Rwanda	Census	2002
179	BLM	Saint Barthelemy	CARIBBEAN	Saint Barthelemy	Census	2009
180	SHN	Saint Helena	ATLANTIC	Saint Helena	Research	2010
181	KNA	Saint Kitts and Nevis	CARIBBEAN	Saint Kitts and Nevis	Census	2001
182	LCA	Saint Lucia	CARIBBEAN	Saint Lucia	Census	2001
183	MAF	Saint Martin (French part)	CARIBBEAN	Saint Martin	Census	2009
184	SPM	Saint Pierre and Miquelon	ATLANTIC	Saint Pierre and Miquelon	Research	2010
185	VCT	Saint Vincent & the Grenadines	CARIBBEAN	Saint Vincent & Grenadines	Census	2001
	186WSM	Samoa	OCEANIA	Samoa	Census	2011
187	SMR	San Marino	EUROPE	Italy	WHE	2007

#	ISO-3	COUNTRY NAME	REGION	REFERENCE COUNTRY	SOURCE	YEAR
188	STP	Sao Tome and Principe	ATLANTIC	Sao Tome and Principe	Research	2010
189	SAU	Saudi Arabia	ASIA	Saudi Arabia	Research	2004
190	SEN	Senegal	AFRICA	Senegal	Census	2002
191	SRB	Serbia	EUROPE	Macedonia	WHE	2007
192	SYC	Seychelles	INDIAN OCEAN	Maldives	Census	2006
193	SLE	Sierra Leone	AFRICA	Sierra Leone	Census	2004
194	SGP	Singapore	ASIA	Taiwan	WHE	2009
195	SVK	Slovakia	EUROPE	Hungary	Census	2001
196	SVN	Slovenia	EUROPE	Slovenia	WHE	2007
197	SLB	Solomon Islands	OCEANIA	Solomon Islands	Census	2000
198	SOM	Somalia	AFRICA	Ethiopia	Census	2007
199	ZAF	South Africa	AFRICA	South Africa	Research	2009
200	SGS	Georgia & Sandwich Islands	ATLANTIC	South Georgia, Sandwich Islands	Research	2010
201	ESP	Spain	EUROPE	Spain	WHE	2007
202	LKA	Sri Lanka	ASIA	India	WHE	2007
203	SDN	Sudan	AFRICA	Sudan	Census	2008
204	SUR	Suriname	S-AMERICA	Guyana	UN	1980
205	SJM	Svalbard and Jan Mayen	ATLANTIC	Svalbard	Research	2010
206	SWZ	Swaziland	AFRICA	Swaziland	Census	2007
207	SWE	Sweden	EUROPE	Norway	Research	2005
208	CHE	Switzerland	EUROPE	Switzerland	WHE	2007
209	SYR	Syrian Arab Republic	ASIA	Syria	Research	2004
210	TWN	Taiwan, Province of China	ASIA	Taiwan	WHE	2009
211	TJK	Tajikistan	ASIA	Kyrgyzstan	WHE	2007
212	TZA	Tanzania, United Republic of	AFRICA	Tanzania	Census	2002
213	THA	Thailand	ASIA	Thailand	Census	2000
214	TLS	Timor-Leste	ASIA	Indonesia	WHE	2007
215	TGO	Togo	AFRICA	Togo	Research	2010
216	TKL	Tokelau	OCEANIA	Tokelau	Census	2006
217	TON	Tonga	OCEANIA	Tonga	Census	2006
218	TTO	Trinidad and Tobago	CARIBBEAN	Trinidad and Tobago	Census	2000
219	TUN	Tunisia	AFRICA	Tunisia	Census	2004
220	TUR	Turkey	ASIA	Turkey	WHE	2007
221	TKM	Turkmenistan	ASIA	Kyrgyzstan	WHE	2007

#	ISO-3	COUNTRY NAME	REGION	REFERENCE COUNTRY	SOURCE	YEAR
222	TCA	Turks and Caicos Islands	CARIBBEAN	Turks and Caicos Islands	Census	2001
223	TUV	Tuvalu	OCEANIA	Tuvalu	Census	2002
224	UGA	Uganda	AFRICA	Uganda	Census	2002
225	UKR	Ukraine	EUROPE	Hungary	Census	2009
226	ARE	United Arab Emirates	ASIA	Bahrain	Census	2010
227	GBR	United Kingdom	EUROPE	United Kingdom	WHE	2007
228	USA	United States	N-AMERICA	United States	HAZUS	2002
229	URY	Uruguay	S-AMERICA	Uruguay	UN	1996
230	UMI	US Minor Outlying Islands	OCEANIA	US Minor Outlying Islands	Research	2000
231	UZB	Uzbekistan	ASIA	Kyrgyzstan	WHE	2007
232	VUT	Vanuatu	OCEANIA	Vanuatu	UN	1993
233	VEN	Venezuela	S-AMERICA	Venezuela	WHE	2007
234	VNM	Viet Nam	ASIA	Myanmar	Research	2011
235	VGB	Virgin Islands, British	CARIBBEAN	British Virgin Islands	Census	2001
236	VIR	Virgin Islands, U.S.	CARIBBEAN	British Virgin Islands	Census	2001
237	WLF	Wallis and Futuna	OCEANIA	Fiji	Census	1996
238	ESH	Western Sahara	AFRICA	Morocco	Research	2009
239	YEM	Yemen	ASIA	Yemen	Research	2004
240	ZMB	Zambia	AFRICA	Zambia	Census	2000
241	ZWE	Zimbabwe	AFRICA	Swaziland	Census	2007
242	XFF	California	N-AMERICA	California	HAZUS	2002

Building Stock Grouping of Countries

After considering all sources that group countries with similar building stock, we decided on the grouping shown in Figures 1 through 6 and Tables 2 through 11. The groups are identified by color codes in the following figures. The reference country in each group is identified by stippling.

AFRICA

Table 2: Independent and groups of countries with similar building stock for Africa. Reference countries are bolded. Origin and date of the data are mentioned.

NAME	GROUP_NAME	SOURCE	YEAR
Benin	Independent	Census	2001
Burkina Faso	Independent	Census	2006
Egypt	Independent	Research	2012
Kenya	Independent	Census	2009
Lesotho	Independent	Census	2006
Liberia	Independent	Census	2008
Madagascar	Independent	Research	2010
Malawi	Independent	Census	2008
Mali	Independent	Research	2009
Mozambique	Independent	Census	2007
Nigeria	Independent	Research	2006
Sierra Leone	Independent	Census	2004
South Africa	Independent	Research	2009
Sudan	Independent	Census	2008
Togo	Independent	Research	2010
Tunisia	Independent	Census	2004
Uganda	Independent	Census	2002
United Republic of Tanzania	Independent	Census	2002
Zambia	Independent	Census	2000
Central African Republic			
Cameroon Equatorial Guinea	Central Africa A	Research	2012
Angola			
Democratic Republic of the Congo Congo	Central Africa B	Research	2012
Gabon			
Burundi Rwanda	Eastern Africa	Census	2002
Djibouti			
Eritrea Ethiopia Somalia	Horn of Africa	Census	2007
Algeria Libyan Arab Jamahiriya	Mediterranean Africa	WHE/PAGER	2007
Western Sahara			
Morocco Mauritania	Saharan Africa A	Research	2009
Niger Chad	Saharan Africa B	Census	2001
Botswana Namibia	Southern Africa A	Research	2006
Swaziland Zimbabwe	Southern Africa B	Census	2007
Cape Verde			
Gambia			
Guinea Guinea-Bissau	Western Africa A	Census	2002
Senegal			
Cote d'Ivoire Ghana	Western Africa B	Research	2010

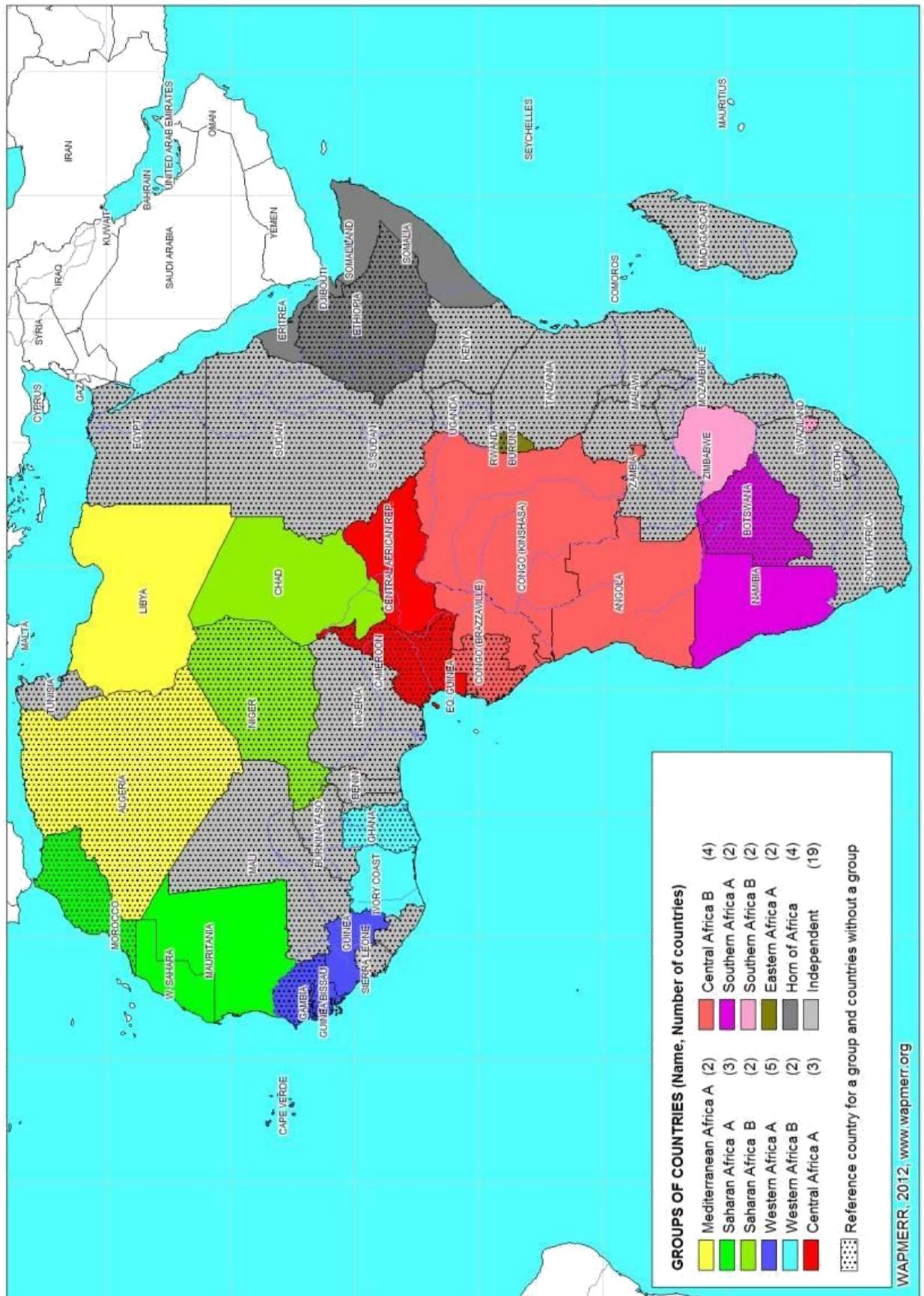


Figure 1: Map of Africa showing groups of countries with similar building stock. Reference and independent countries are marked by stippling.

ASIA

Table 3: *Independent and groups of countries with similar building stock for Asia. Reference countries are bolded. Origin and date of the data are mentioned.*

NAME	GROUP_NAME	SOURCE	YEAR
Bangladesh	Independent	Research	2007
Georgia	Independent	WHE	2009
Iraq	Independent	Research	2004
Israel	Independent	Research	2010
Mongolia	Independent	WHE	2007
Nepal	Independent	WHE	2007
Pakistan	Independent	Research	2008
Russia	Independent	WHE	2007
Thailand	Independent	Census	2000
Turkey	Independent	WHE	2007
Yemen	Independent	Other	2012
Kuwait Oman	Western Asia A	Research	2004
Saudi Arabia			
United Arab Emirates			
Bahrain Qatar	Western Asia B	Census	2010
Armenia Azerbaijan	Western Asia C	Research	2007
Lebanon			
Syrian Arab Republic	Middle East A	Research	2004
Jordan Palestine	Middle East B	Census	2004
Afghanistan			
Iran (Islamic Republic of)	Southern Asia A	Census	2005
Bhutan			
India Sri Lanka	Southern Asia B	WHE	2007
Indonesia			
Papua New Guinea Timor-Leste	South-Eastern Asia A	WHE	2007
Brunei Darussalam			
Malaysia	South-Eastern Asia B	Census	2000
Philippines			
Cambodia Lao People's Democratic Republic	South-Eastern Asia C	Research	2011
Myanmar Viet Nam			
China North Korea	Eastern Asia A	WHE	2007
Japan South Korea	Eastern Asia B	WHE	2007
Hong Kong Macau Singapore	Eastern Asia C	WHE	2009
Taiwan			
Kyrgyzstan Kazakhstan Tajikistan Turkmenistan Uzbekistan	Northern Asia	WHE	2007

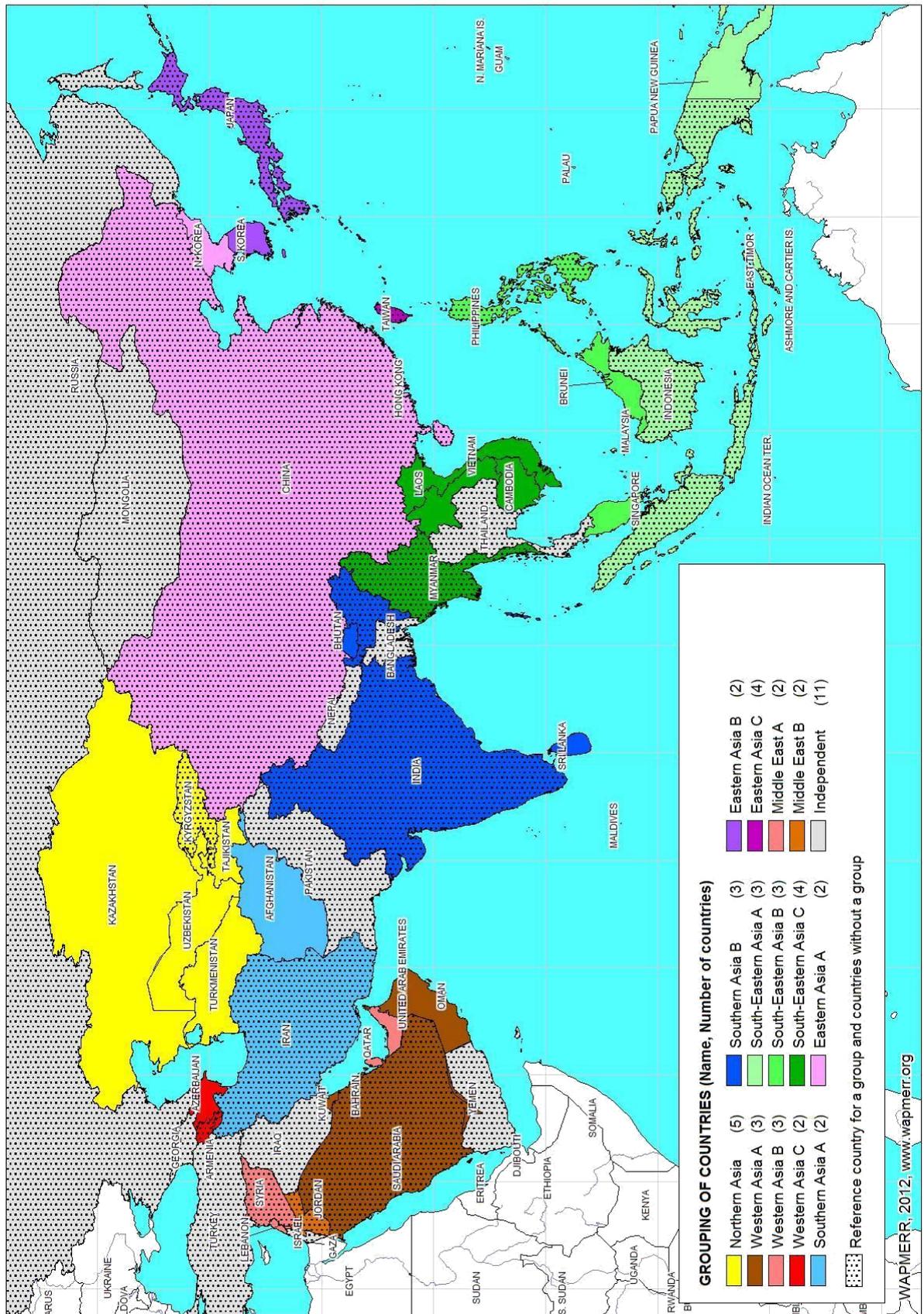


Figure 2: Map of Asia showing groups of countries with similar building stock. Reference and independent countries are marked by stippling.

CARIBBEAN

Table 4: *Independent and groups of countries with similar building stock for Caribbean.*

Reference countries are bolded. Origin and date of the data are mentioned.

NAME	GROUP_NAME	SOURCE	YEAR
Anguilla	Independent	Census	2001
Antigua and Barbuda	Independent	Census	2001
Bahamas	Independent	Census	2000
Barbados	Independent	Census	2000
Bermuda	Independent	Research	2010
Dominica	Independent	Census	2001
Grenada	Independent	Census	2001
Haiti	Independent	Census	2003
Jamaica	Independent	Census	2001
Montserrat	Independent	Census	2001
Saint Barthelemy	Independent	Census	2009
Saint Kitts and Nevis	Independent	Census	2001
Saint Lucia	Independent	Census	2001
Saint Martin	Independent	Census	2009
Saint Vincent & the Grenadines	Independent	Census	2001
Trinidad and Tobago	Independent	Census	2000
Turks and Caicos Islands	Independent	Census	2001
Belize	Eastern Caribbean	Census	2001
Cayman Islands		Census	2001
Dominican Republic	Central Caribbean		2010
Puerto Rico		Census	2010
British Virgin Islands	US and European Caribbean		2001
United States Virgin Islands		Census	2001
Guadeloupe	French Caribbean		2009
Martinique		Research	2009
Netherlands Antilles	Southern Caribbean		2001
Aruba		Census	2001

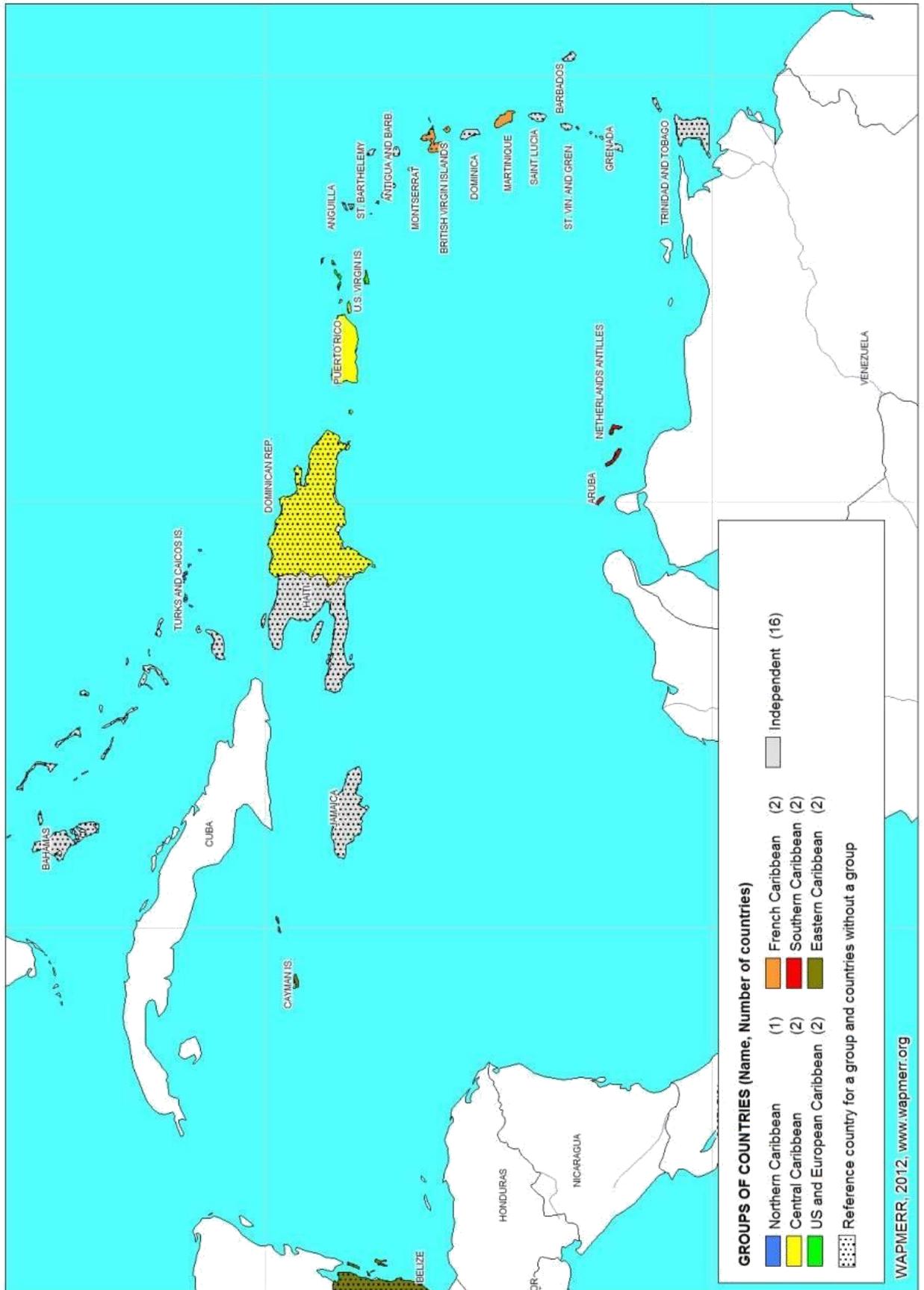


Figure 3: Map of the Caribbean showing groups of countries with similar building stock. Reference and independent countries are marked by stippling.

AMERICA

Table 5: *Independent and groups of countries with similar building stock for North America. Reference countries are bolded. Origin and date of the data are mentioned.*

NAME	GROUP_NAME	SOURCE	YEAR
Canada	North America	HAZUS	2002
United States			

Table 6: *Independent and groups of countries with similar building stock for Central America. Reference countries are bolded. Origin and date of the data are mentioned.*

NAME	GROUP_NAME	SOURCE	YEAR
Cuba	Independent	UN	1981
El Salvador	Independent	Census	1990
Guatemala	Independent	UN	1998
Honduras	Independent	UN	2005
Mexico	Independent	WHE	2007
Costa Rica	Central-America	UN	2001
Nicaragua			
Panama			

Table 7: *Independent and groups of countries with similar building stock for South America. Reference countries are bolded. Origin and date of the data are mentioned.*

NAME	GROUP_NAME	SOURCE	YEAR
Argentina	Independent	WHE	2009
Bolivia	Independent	UN	2004
Brazil	Independent	UN	1996
Chile	Independent	WHE	2007
Colombia	Independent	WHE	2007
Venezuela	Independent	WHE	2007
Ecuador	South-America A	WHE	2007
Peru			
Paraguay	South-America B	UN	1996
Uruguay			
French Guiana	South-America C	UN	1980
Guyana			
Suriname			

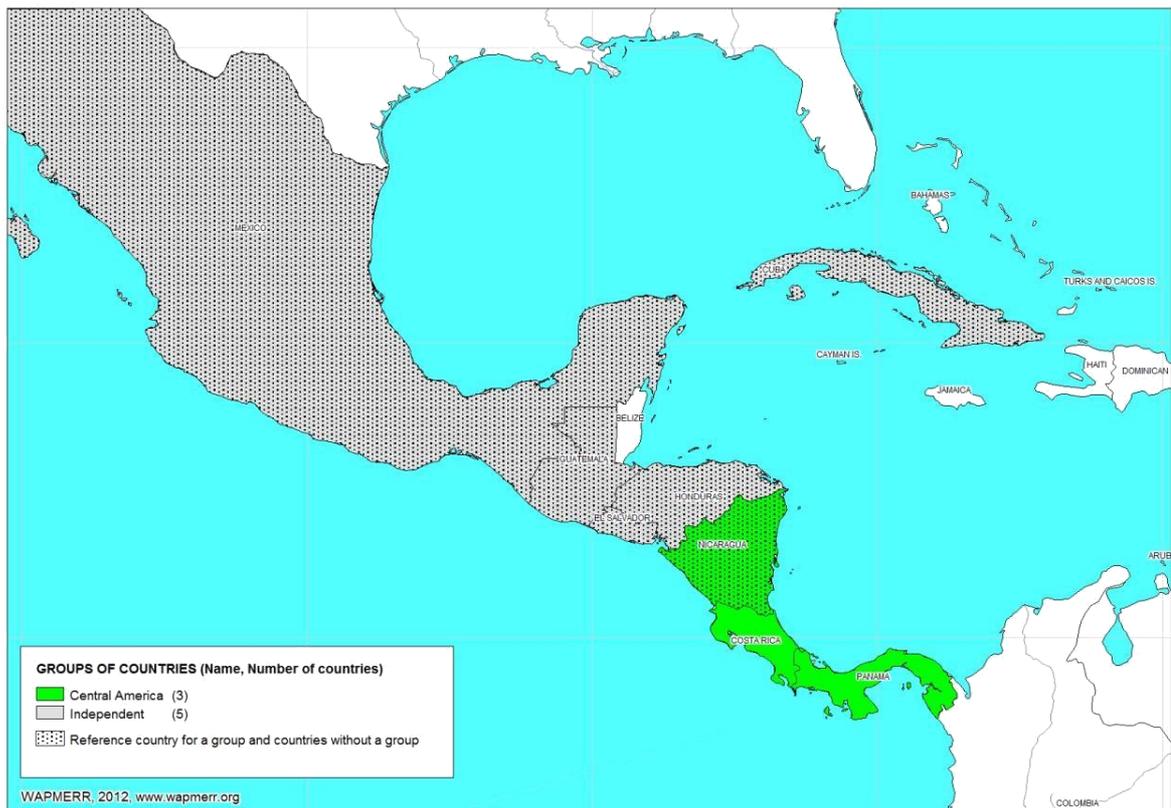


Figure 4: Map of Central America showing groups of countries with similar building stock. Reference and independent countries are marked by stippling.

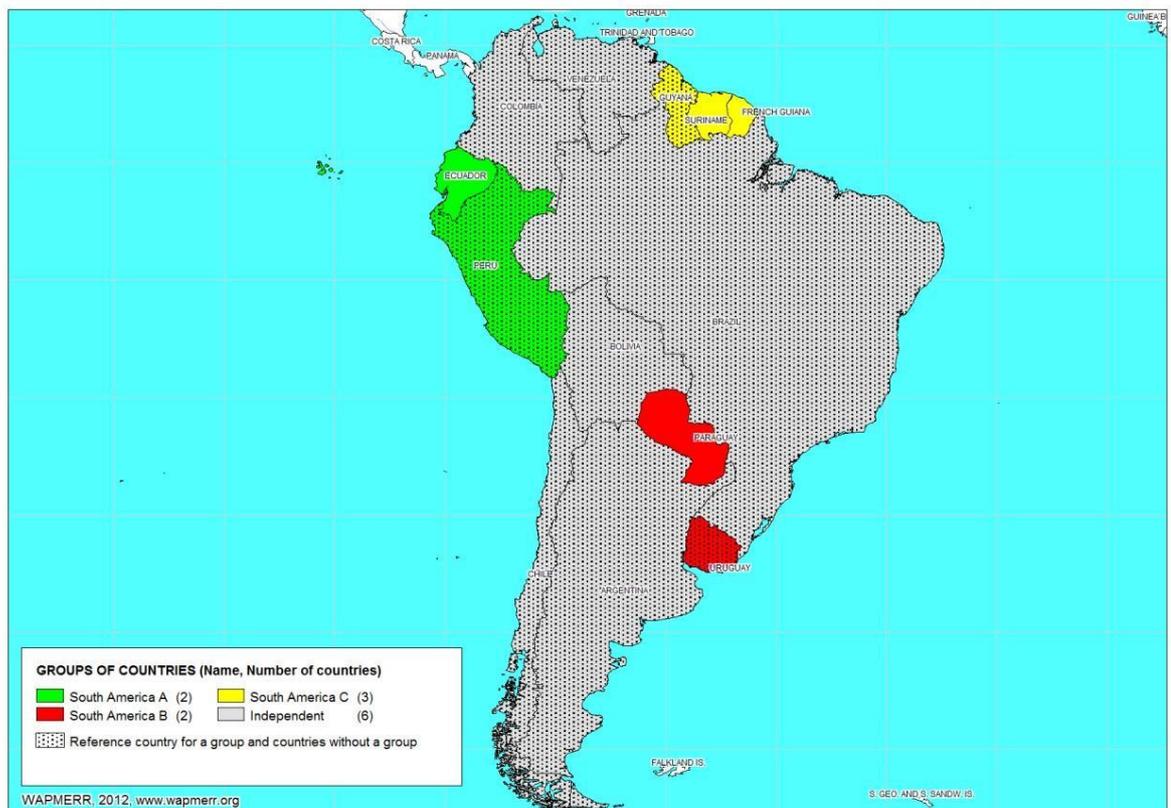


Figure 5: Map of South America showing groups of countries with similar building stock. Reference and independent countries are marked by stippling.

EUROPE

Table 8: *Independent and groups of countries with similar building stock for Europe.*

Reference countries are bolded. Origin and date of the data are mentioned.

NAME	GROUP_NAME	SOURCE	YEAR
Bulgaria	Independent	Census	2005
Romania	Independent	WHE	2009
Republic of Moldova	Independent	UN	2005
Faroe Islands	Independent	UN	1977
Cyprus	Independent	WHE	2007
Ireland	Independent	WHE	2007
Greece	Independent	WHE	2007
Austria			
France			
Germany	Western Europe A	WHE	2007
Liechtenstein			
Switzerland			
Belgium			
Luxembourg	Western Europe B	Research	2007
Netherlands			
Andorra			
Portugal	Southern Europe A	WHE	2007
Spain			
Italy			
Malta			
Monaco	Southern Europe B	WHE	2007
San Marino			
Vatican City			
Albania			
Bosnia and Herzegovina			
Macedonia FYRO	Balkan A	WHE	2007
Montenegro			
Serbia			
Croatia	Balkan B	WHE	2007
Slovenia			
Gibraltar			
Guernsey			
Isle of Man	Atlantic Europe	WHE	2007
Jersey			
United Kingdom			
Czech Republic			
Hungary	Eastern Europe A	Census	2001
Poland			
Slovakia			
Belarus	Eastern Europe B	Census	2009
Ukraine			
Estonia			
Latvia	Baltic	Census	2001
Lithuania			
Denmark			
Finland	Scandinavia	Research	2005
Iceland			
Norway			

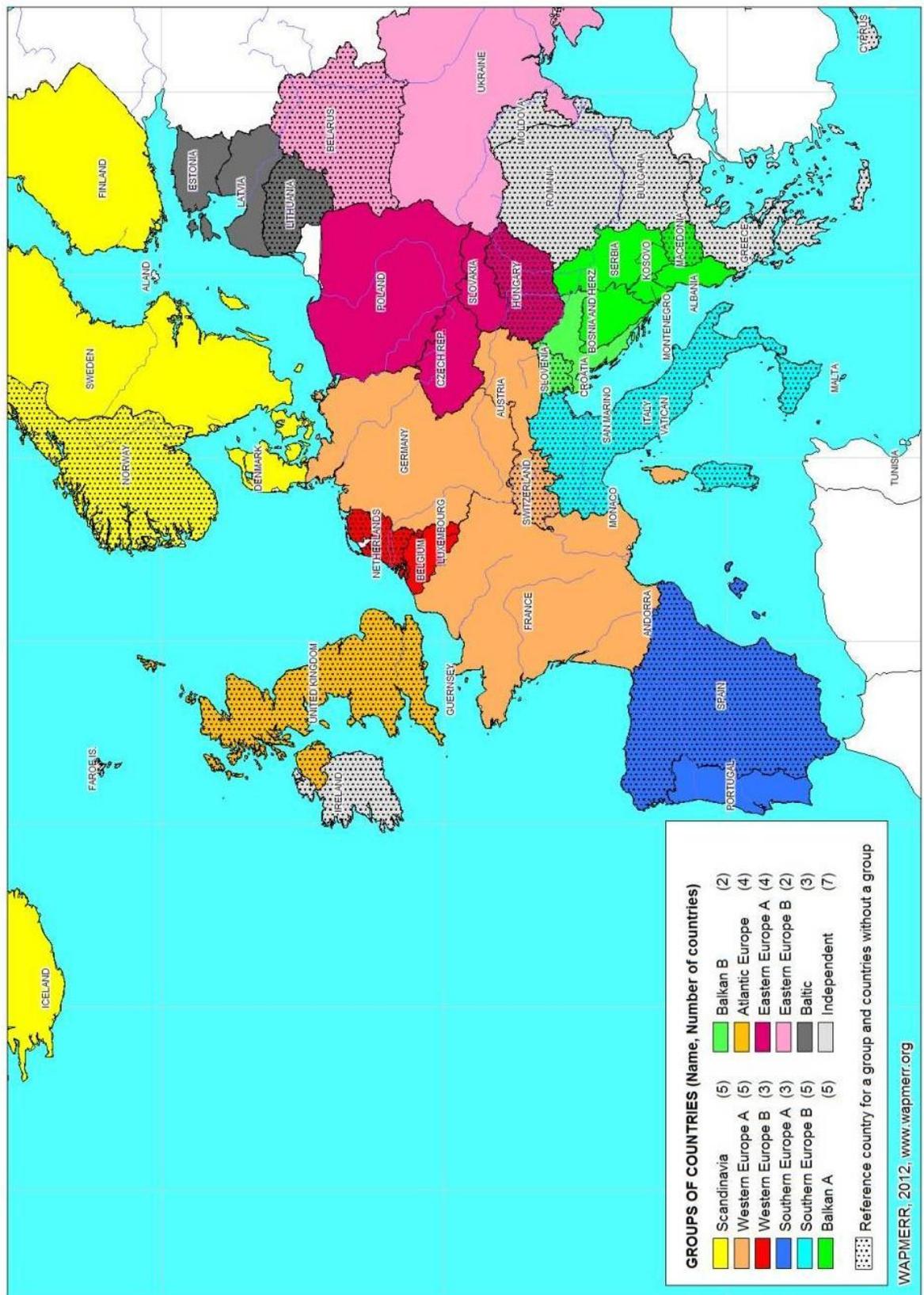


Figure 5: Map of Europe showing groups of countries with similar building stock. Reference and independent countries are marked by stippling.

OCEANIA

Table 9: *Independent and groups of countries with similar building stock for Oceania.*

Reference countries are bolded. Origin and date of the data are mentioned.

NAME	GROUP_NAME	SOURCE	YEAR
American Samoa	Independent	Census	2011
French Polynesia	Independent	Census	2007
Guam	Independent	Census	2000
Micronesia	Independent	UN	1993
Norfolk Island	Independent	Census	2011
Northern Mariana Islands	Independent	Research	2007
Samoa	Independent	Census	2011
Solomon Islands	Independent	Census	2000
Tokelau	Independent	Census	2006
United States Minor Outlying Islands	Independent	Research	2000
Nauru			
Palau	Pacific A	Census	2005
Pitcairn Islands			
Fiji			
Marshall Islands	Pacific B	Census	1996
Wallis and Futuna Islands			
Niue			
Tonga	Pacific C	Census	2006
Cook Islands			
Tuvalu	Pacific D	Census	2002
Kiribati			
New Caledonia	Pacific E	UN	1993
Vanuatu			

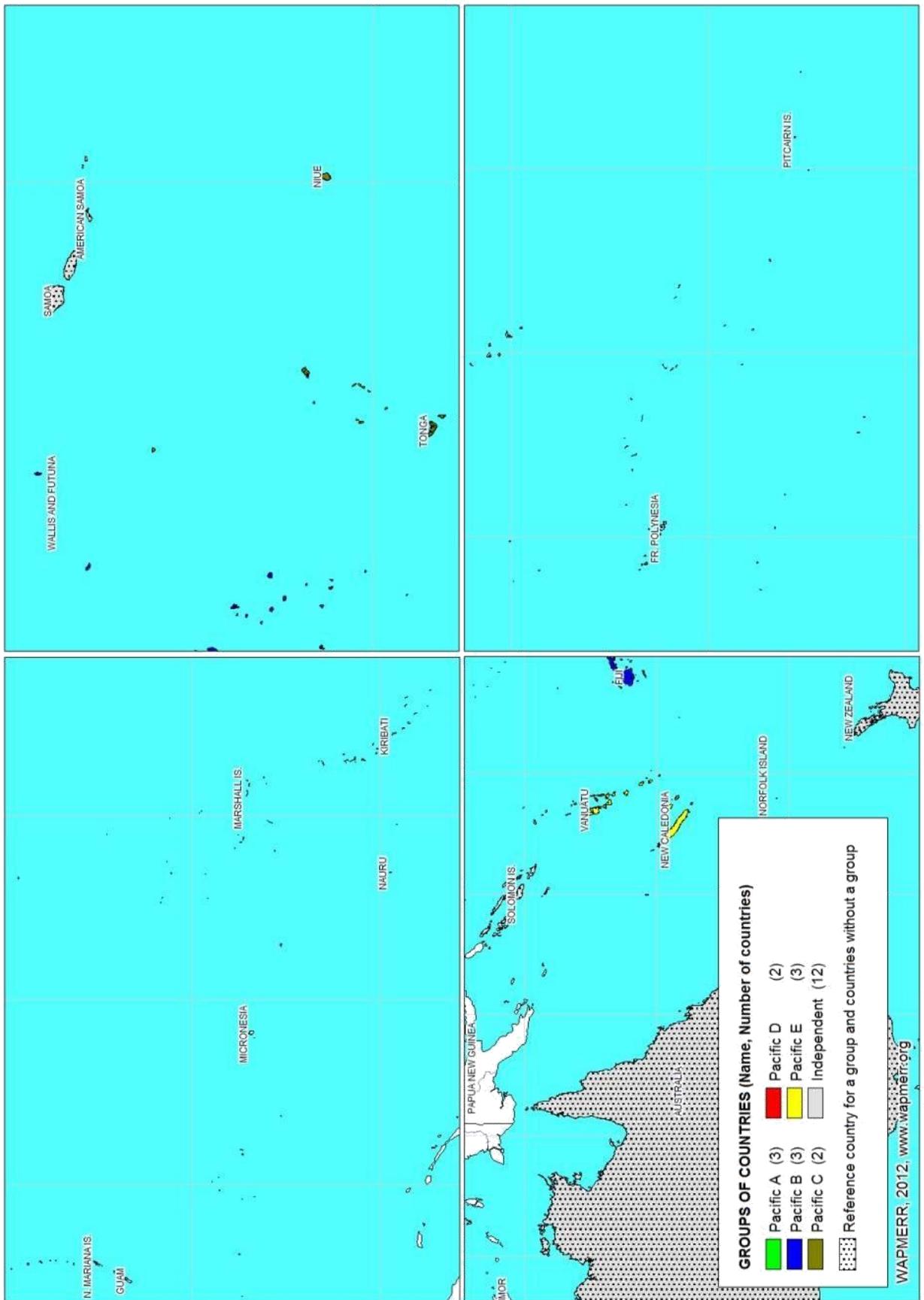


Figure 6: Maps of Oceania showing groups of countries with similar building stock. Reference and independent countries are marked by stippling.

INDIAN AND ATLANTIC OCEANS

Table 10: *Independent and groups of countries with similar building stock for Indian Ocean. Reference countries are bolded. Origin and date of the data are mentioned.*

NAME	GROUP_NAME	SOURCE	YEAR
British Indian Ocean Territory	Independent	Research	2012
Bouvet Island	Independent	Research	2012
Comoros	Independent	Research	2000
French Southern & Antarctic Lands	Independent	Research	2012
Heard Island and McDonald Islands	Independent	Research	2012
Mayotte	Independent	Census	2007
Mauritius Reunion	Western Indian Ocean	Census	2011
Maldives Seychelles	Central Indian Ocean	Census	2006
Cocos (Keeling) Islands Christmas Island	Eastern Indian Ocean	UN	1993

Table 11: *Independent and groups of countries with similar building stock for Atlantic islands. Reference countries are emboldened. Origin and date of the data are mentioned.*

NAME	GROUP_NAME	SOURCE	YEAR
Falkland Islands (Malvinas)	Independent	Research	2010
South Georgia South Sandwich Islands	Independent	Research	2010
Saint Pierre and Miquelon	Independent	Research	2010
Saint Helena	Independent	Research	2010
Svalbard	Independent	Research	2010
Sao Tome and Principe	Independent	Research	2010

The origin of building and occupancy data for individual countries are provided under separate cover as Appendix A.

Characteristics of the Data

The largest fraction of *the data sources*, 40%, was from censuses (Figure 7). The portions developed through research and the one from the WHE/PAGER project were about the same, 25%. United Nations data made up 21%.

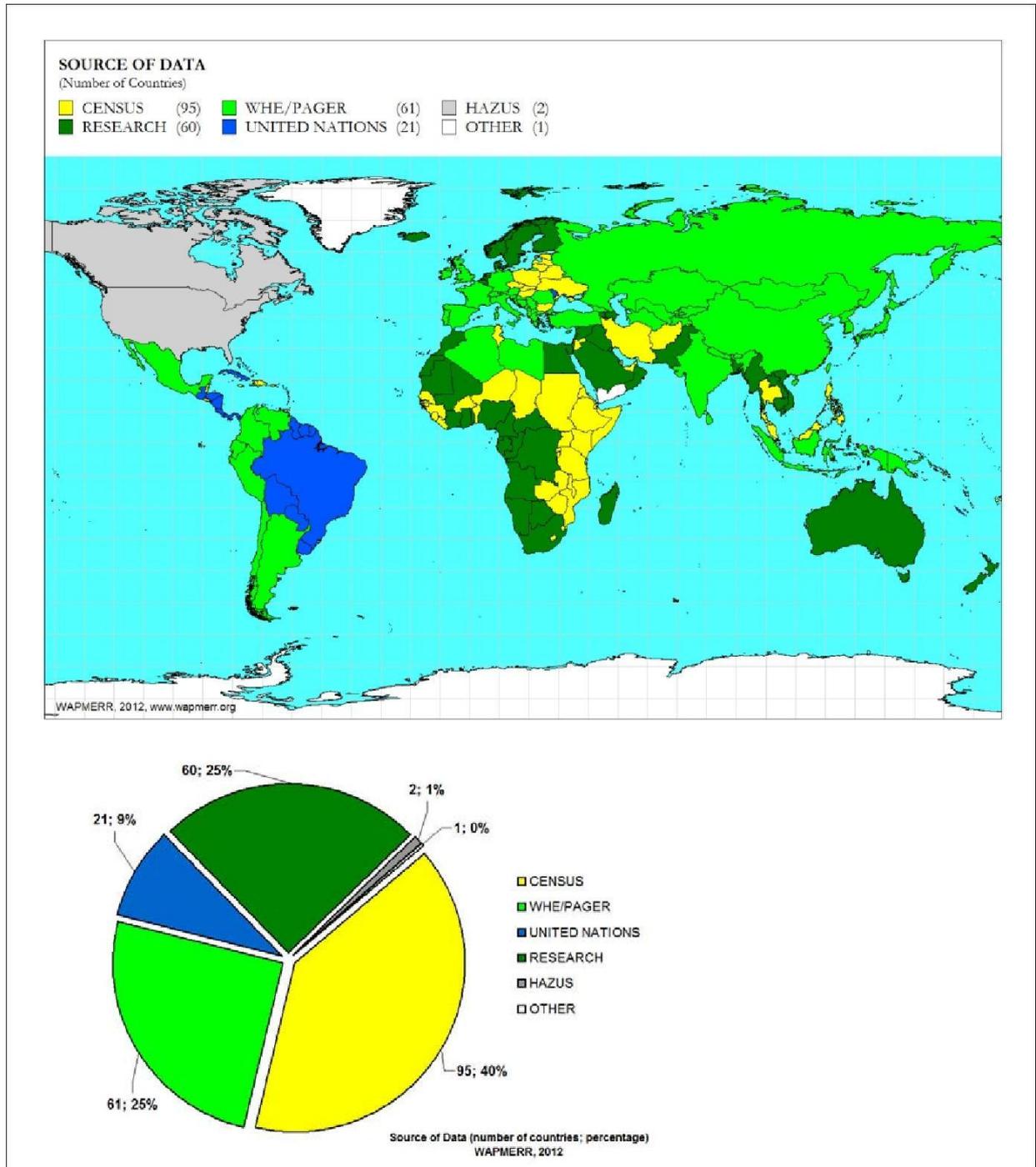


Figure 7: Map of the source of building type data (top) and distribution into different types of sources (bottom).

The years of the data ranged from 1977 through 2012, with about 50% from 2007 on (Figure 8).

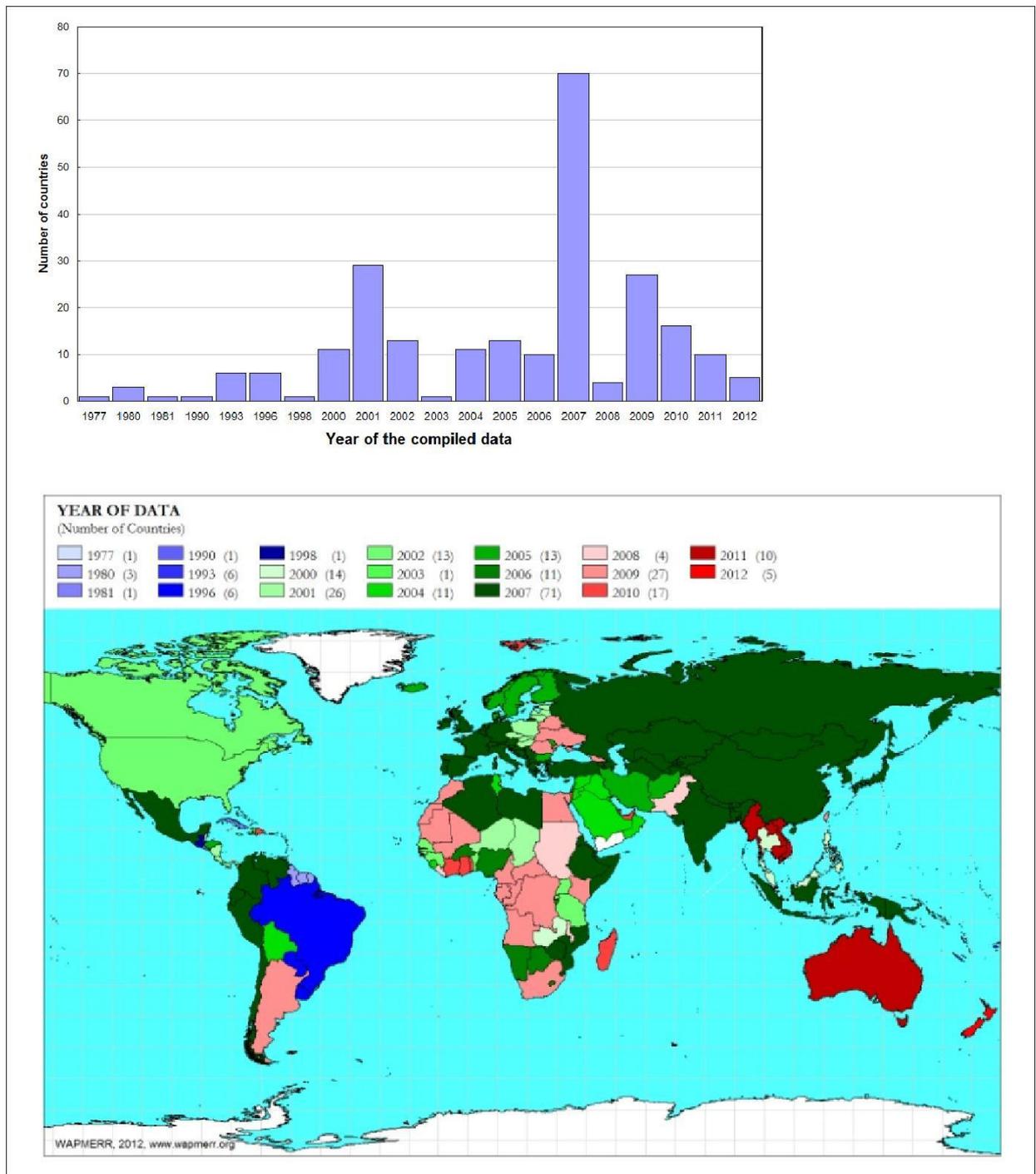


Figure 8: Numbers of countries as a function of the year of the data origin (top) and map of the year color coded for each country.

The *quality of the data* was estimated using expert judgment and is shown on the map of Figure 9.

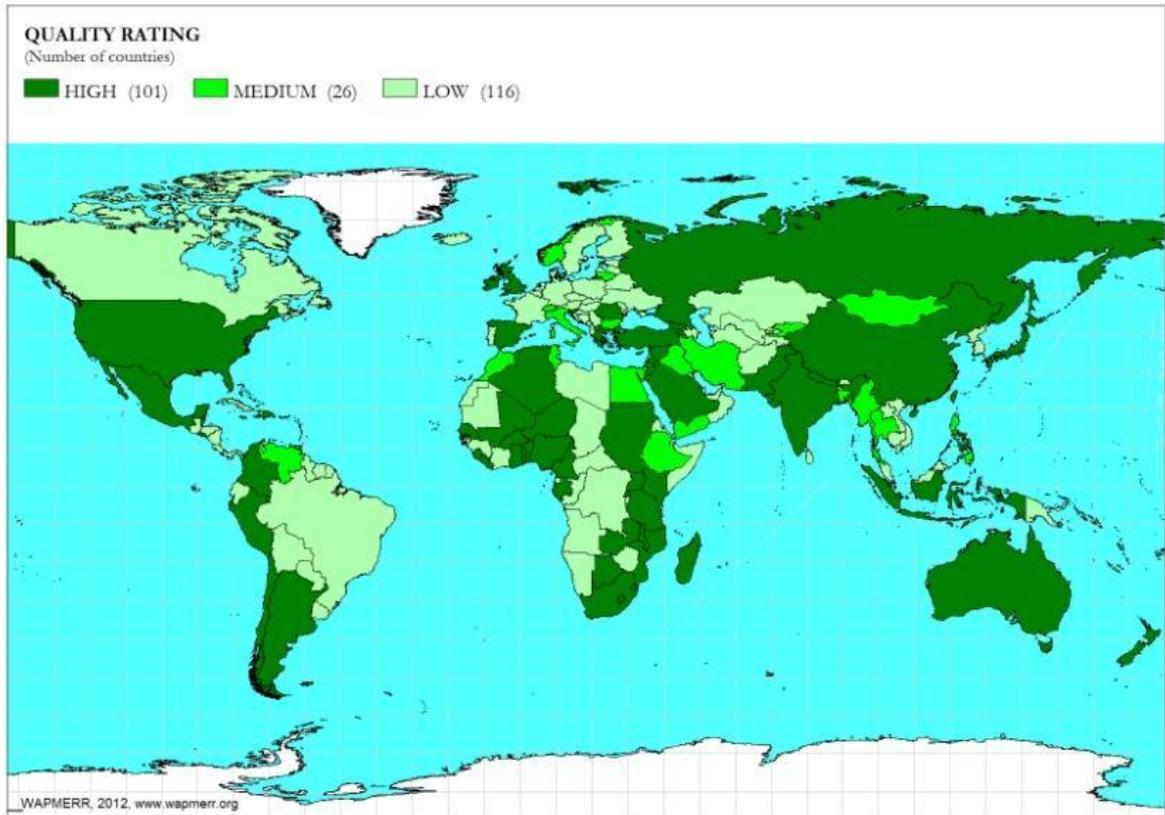


Figure 9: Map showing the estimated data quality for each country.

Method for Constructing the Database for Building Types in Three Size Classes of Settlements

Initially, we searched the Statistics Office of each country for housing census data and occupancy rates. In case the data collected were not satisfactory, useful data from any other source available in the internet (mainly research publications, reports and photos) were sought. Then, building types described in the data were interpreted and converted to the PAGER building types (Jaiswal and Wald, 2008).

Population distributions were transformed to building stock distributions and vice versa using occupancy rates. For all countries, collected photos of buildings and settlements, both rural and urban, were reviewed to verify the proposed building types and distributions, but also to validate the grouping of countries.

In several cases, population data are given into Residential and Non-Residential groups. The Residential and Non-Residential distributions are combined to form urban and rural population distributions according to the following relations:

$$2/3 \times \text{UrbanResidential} + 1/3 \times \text{UrbanNonResidential} = (\text{Major}) \text{ Urban}$$

$$3/4 \times \text{RuralResidential} + 1/4 \times \text{RuralNonResidential} = \text{Rural}$$

The distribution for the Minor Urban class (inhabitants between 2'000 and 20'000) is taken as the average of those in the Major Urban (>20'000) and the Rural settlements (<2'000) using the population distributions.

Our current estimates of occupancy rate by building type for 242 countries of the world is attached as Appendix B in excel-format.

Preliminary Comparison of QLARM with LandScan Urban Data.

For a comparison of LandScan urban with QLARM data, we used a theoretical calculation of probable damage of a recent earthquake: M6.8 in Myanmar on November 11, 2012 (Figure 10). The polygons in the LandScan data are represented as dots, as are the settlement in the QLARM data. The settlements and population in the QLARM data are more numerous than in the LandScan data and the population distribution is modeled in much greater detail.

The populations affected by the M6.8 earthquake

are: ☹ QLARM (Intensity IV-VIII):

5,159,575 ☹ LANDSCAN (Intensity IV-

VII): 2,320,123

We understand that this difference is due to the fact that the LandScan urban data contains only urban polygons. The result is that the population of Myanmar in LandScan is modeled by only 30% of the known population. The population assumed to be affected in the LandScan model is only half of that in the QLARM model; in the area affected by the earthquake (Figure 10).

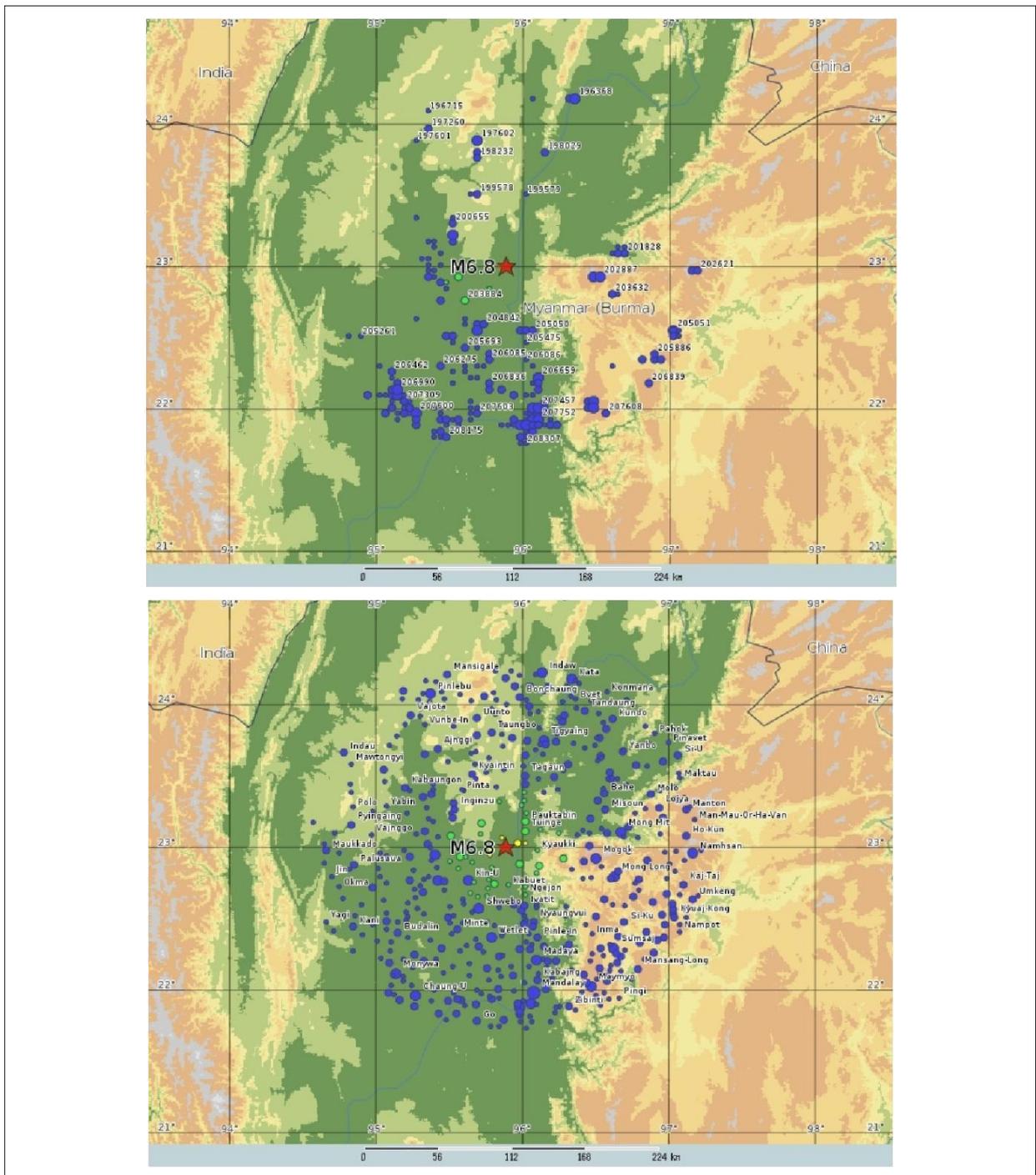


Figure 10: Map of calculated mean damage due to the M6.8 earthquake of 11 November 2012 in Myanmar; top LandScan urban data, and bottom QLARM data. The color indicates the mean damage, ranging from blue (minor) to yellow (significant).

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