

# Index

## Index | Key

- An asterisk (\*) indicates the term also appears in the Glossary.
- Page numbers in bold indicate page spans for entire chapters.
- Page numbers in italics denote figures, tables, boxed material.

## A

**Abrupt climate change\***, 15, 63, 64, 67, 276  
paleontological records, 421-423

**Acclimatization\***, 49, 287, 426, 427

**Acidification**. See Ocean acidification

**Active transport**, 714, 742

**Adaptation\***, 14-28, 39, 59-84, **833-977**, **1101-1131**  
about: relationship between adaptation chapters, 838, 1115-1117  
actors and roles in, 836  
adaptation as development, 816  
ancillary benefits of, 910-911, 948  
assessment\* (See Adaptation assessment)  
autonomous\*, 321-324, 815, 1284-1286, 1472-1473, 1531, 1538-1539  
barriers to, 233, 906, 1476  
climate change magnitude and rate and, 1121  
climate policies, 89-90, 171, 909, 922, 948-949  
community-based\* (See Community-based adaptation)  
Copenhagen Accord, pledges, 1115  
core concepts and entry points, 26, 85  
costs and benefits (See Adaptation costs and benefits)  
decision making and governance, 9-11, 54-56, 85-87, 388-390, 389, 638, 836, 1118  
definition of, 40, 853  
development and, 816, 882, 948, 954, 1473  
disagreements about, 180-182  
disaster risk management and, 836  
as dynamic issue, 951  
early, 878  
economics of (See Adaptation economics)  
ecosystem-based\* (See Ecosystem-based adaptation)  
emergent risks and, 1060-1061  
ethical dimensions, 903, 925-927, 926  
evolutionary\*, 322-323, 415, 426  
experience, 8-9, 51-55, 52-55  
facilitating, 888, 908, 948, 965  
feedbacks in, 9  
first step as vulnerability reduction in present, 25-26, 85, 1502, 1531, 1545  
framing and focus of, 836, 838-839, 874, 948  
funding gap, 28, 87, 844, 953  
genetic and evolutionary responses, 322-323, 426, 1709  
global, costs and benefits, 392-393  
goals, 836  
human-assisted, 324-326, 325, 328  
incremental\*, 733, 1121, 1445  
indigenous knowledge in, 87, 758, 766  
inter-relationship with mitigation (See Adaptation and mitigation inter-relationships)  
in IPCC assessment reports, 180-182  
limits to (See Adaptation limits)

local government and, 836, 842-843, 849  
mainstreaming, 87, 948, 1351-1352  
maladaptation\*, 87, 254, 518, 837, 857-859, 1476  
management decisions, 324-325  
measuring, 853-857, 855  
metrics, 853-857  
micro-finance for, 584  
mitigation and (See Adaptation and mitigation inter-relationships)  
National Adaptation Programmes of Action (NAPAs), 215, 816, 836, 852, 873, 880, 1111  
needs and options (See Adaptation needs and options)  
opportunities, constraints, and limits (See Adaptation opportunities, constraints, and limits)  
pathways, 1116-1117, 1386-1387  
planning and implementation (See Adaptation planning and implementation)  
principles for, 25-28, 85-87  
private sector engagement, 843-844, 876, 876, 880-881, 886  
regional, 8-9, 21-25, 90-91, 1145-1148, 1152-1157  
risk management and, 56, 253-258, 1104-1105, 1117-1118  
sectoral synthesis, 14-20, 922  
synergies, 28, 87  
technology and, 885  
trans-generational, 415  
transformational\* (See Transformational adaptation)  
transitional, 733  
unintended consequences of, 277, 327-328  
See also *specific systems and regions*

**Adaptation and mitigation inter-relationships**, 26, 28, 180-181, 1080-1083  
in Asia, 1352-1353  
co-benefits, 89-91, 1104, 1118  
decision processes, 216-218, 217  
examples, 90-91  
integration of adaptation and mitigation, 1104, 1117-1118  
sustainable development and, 216-217, 217, 1109-1110  
synergies and trade-offs, 89-91, 216, 217, 394, 925, 1104

**Adaptation assessment\***, 51, 837, 850-853, 1176-1184  
analysis and reliability of, 1176-1184  
first-generation, 851  
national assessments, 852-853  
purpose of, 850  
regional, 1176-1184  
scale in, 1149  
scenario-based, 213, 851  
second-generation, 851  
istandard approach to, 850-851  
top-down and bottom-up, 851, 1144, 1144  
trends in, 850-851

**Adaptation constraints\***, 87, 902, 906, 911-919  
adaptation needs and, 844-845  
assessing, 901  
biological, 902, 913-914, 922  
in coastal areas, 393-394  
competing values, 917  
cross-scale dynamics, 912, 918-919

cultural factors, 902  
definition of, 907  
differences from barriers, obstacles, and limits, 906  
economic, 914, 922  
ethical dimensions, 903, 925-927, 926  
financial, 914-915  
governance and institutional, 916-917, 922  
hard and soft limits, 89, 903, 907, 919-921  
human resource, 915, 922  
institutional factors, 902  
knowledge, awareness, and technology, 911-913, 922  
overcoming, 927  
physical, 913, 922  
risk-based framework, 902, 905-908, 906  
in rural areas, 617, 642-643  
sectoral and regional synthesis, 922-924, 922  
social and cultural, 902, 915-916, 922  
in urban areas, 540  
See also Adaptation opportunities, constraints, and limits

**Adaptation costs and benefits**, 392-393, 948, 952-953, 953, 958-963  
ancillary benefits, 948  
broad categorization of, 952  
in coastal systems, 364, 392-393, 395  
cost-benefit analysis, 948, 956-957, 963  
in freshwater resources, 256  
global adaptation costs, 392-393, 949, 959-960, 959, 960  
new thinking on, 948  
socioeconomics and, 959  
See also Adaptation economics; Trade-offs

**Adaptation deficit\***, 210, 214, 839

**Adaptation economics**, 26, **945-977**  
adaptation as dynamic issue, 951  
adaptation benefits and costs, residual damage, and projects, 952-953, 953  
adaptation costs, 952-953, 953  
adaptation limits and, 951-952, 952  
adjustment costs, 955  
ancillary benefits/effects, 948, 951  
behavior, role of, 966  
bias in (potential), 967  
biophysical limits to adaptation, 948  
broad-based approach, 948, 949, 951-954, 967, 963  
broad categorization of adaptation strategies, 950  
broad categorization of benefits and costs, 952  
charges, 965-966  
co-benefits, 948, 951, 952, 960  
competitive adaptation, 948, 954  
complementary adaptation, 948, 954  
consistency between localized and global analyses, 960  
coordination, government failures, and political economy, 956  
cost-benefit analysis, 948, 956-957, 963  
costing adaptation, 958-963  
coverage of adaptation costs and benefits, 960  
decision making, 954-958, 954, 963  
decision making, economic barriers to, 955-956  
decision making support, 948  
decision making with uncertainty, 9, 956-958  
development and adaptation, 948, 954  
differences between adaptation potential and achievement, 948

- discount rates, 959  
 disincentives, 949, 964  
 economic analyses, desired characteristics of, 949  
 economic aspects of adaptation, 950-954  
 economic instruments, 26, 87, 948-949, 963-966, 965  
 education, 948, 950, 963  
 eligibility for adaptation funds, 952, 952  
 environmental regulation, 948, 950  
 equity and, 948, 955-956  
 ethics and distributional issues, 955-956  
 facilitating adaptation, 948, 965  
 financing, 948-949, 952  
 global adaptation costs, 949, 959-960, 959, 960  
 incentives, 949, 963-966  
 innovation, 966  
 insurance, 949, 964  
 intellectual property rights, 966  
 mainstreaming, 87, 948, 1351-1352  
 market-based instruments, 965-966  
 market failures, 955  
 missing markets, 955  
 moral hazard, 964  
 multi-metric decision making, 957, 957  
 multi-metric evaluations, 948  
 narrow economic approach, 961  
 narrowing of adaptation, 951-952, 952  
 non-market factors, 948, 951, 956, 958, 960, 961, 962, 963  
 non-monetary considerations, 948-949, 951, 961, 963  
 non-probabilistic methodologies, 949, 957-958  
 Paris agglomeration, 957, 957  
 payment for ecosystem services (PES), 964, 965, 1523, 1540-1541, 1541  
 practical adaptation strategy, 951-952, 952  
 private and public sectors, 948, 950  
 regional and sectoral studies, 949  
 research & development funding, 948, 966  
 residual cost, 952-953, 953  
 resource pricing, 964-965  
 risk financing, 949  
 risk pools, 949, 964  
 risk sharing and transfer, 949, 964  
 robustness, 949, 957-958, 958  
 sectoral and regional studies, 960-963, 960, 962-963  
 subsidies, 949, 965-966  
 taxes, 949, 965-966  
 technology transfer, 966  
 theoretical basis, 948  
 trade-offs, 948  
 transaction costs, 955  
 uncertainty and, 949, 954, 956-958  
 valuation of ecosystem services, 956-957  
 water markets, 964-965
- Adaptation limits\***, 9, 89, 902-903, 906, 919-922, 1085  
 assessing, 902  
 avoiding, 920, 927  
 biophysical, 922, 948  
 change and, 902-903, 912  
 in coastal areas, 393-394  
 definition of, 907  
 differences from constraints, barriers, and obstacles, 906  
 economic, 922  
 ethical dimensions, 903, 925-927, 926  
 exceedance of, 28, 87, 924  
 factors influencing, 951-952, 952  
 hard and soft limits, 89, 903, 907, 919-921  
 historical perspectives, 920  
 interacting systems, 903-904  
 mitigation and, 903, 924-925, 924  
 in ocean systems, 416  
 overview, 902-903  
 risk-based framework, 902, 905-908, 906  
 in rural areas, 617, 642-643  
 scale-dependent properties, 921  
 sectoral and regional synthesis, 922-924, 922  
 social/cultural, 922  
 transformational adaptation and, 89, 921-922, 1121  
 See also Adaptation opportunities, constraints, and limits
- Adaptation needs and options\***, 833-868  
 actors and roles, 836, 841-844  
 adaptation assessments\*, 837, 840, 850-853  
 adaptation constraints and limits\*, 844-845  
 adaptation needs\*, 839-844  
 adaptation options\*, 844-850, 845  
 awareness of, 837, 845, 848  
 behavioral measures, 845, 847  
 biophysical and environmental needs, 840-841  
 broad categorization of adaptation strategies, 950  
 categories of needs and options, 840, 845  
 cost and, 948  
 ecosystem-based adaptation, 845, 846-847  
 engineering and built environment, 845, 846  
 ethics and, 903  
 finance and, 392, 843-844, 845, 848-849  
 freshwater resource management, 254, 255  
 governments and, 836, 842-843, 845, 849  
 information, capacity, and resource needs, 844, 845, 848  
 institutional needs\*, 842-843  
 institutional options\*, 836, 845, 848-849  
 local government involvement, 836, 842-843, 849  
 maladaptation\*, 836, 857-859  
 measuring adaptation, 837, 853-857, 855  
 metrics, 837, 853-857  
 migration as an option, 770-771, 770  
 options in coastal systems, 365  
 policy actions, 948-949  
 private sector engagement, 836, 843-844  
 research and data gaps, 859-860  
 safety nets, 836, 845  
 selection of options, 836, 849-850, 850, 903  
 service provision, 845, 847  
 social needs, 841-842  
 social options, 845, 847-848  
 structural and physical options, 845-847, 845  
 summary of AR4 findings, 839  
 technological options\*, 836, 845, 846  
 trade-offs, 918  
 transformative adaptation, 836  
 vulnerability and, 836, 839-840
- Adaptation opportunities, constraints, and limits\***, 14-28, 59-84, 899-943  
 adaptation constraints\*, 902, 906, 911-919  
 adaptation limits\*, 902-903, 906, 919-922  
 adaptation opportunities\*, 902, 908-911, 909  
 assessing, 902  
 awareness raising, 845, 909, 922  
 capacity building, 902, 909, 922  
 case study of opportunities (Bangladesh), 910  
 changes and, 902-903, 912  
 cross-chapter box, 101-103  
 cross-scale dynamics, 912, 918-919  
 decision support tools, 902  
 definitions, 907  
 ethical dimensions, 903, 925-927, 926  
 facilitating adaptation, 908, 948  
 hard and soft limits, 89, 903, 907, 919-921  
 innovation, 909, 922  
 learning, 902, 909, 922  
 mitigation and, 903, 924-925, 924  
 policy, 909, 922  
 risk-based framework, 902, 905-908, 906  
 sectoral and regional synthesis, 14-25, 62-73, 922-924, 922  
 seizing opportunities, overcoming constraints, and avoiding limits, 927  
 selection and implementation of options, 903  
 summary of AR4 findings, 904-905  
 summary of SREX findings, 905  
 sustainable development and, 909-910  
 tools, 902, 909, 922  
 trade-offs, 918, 925  
 transformational adaptation, 89, 921-922  
 See also Adaptation constraints; Adaptation limits
- Adaptation options.** See Adaptation needs and options
- Adaptation planning and implementation**, 8, 25-26, 51, 85-87, 869-898  
 in Australasia, 1374-1375, 1389-1390  
 in Central and South America, 1531, 1538-1539  
 common recognition, 873-874  
 communication tools, 883  
 decision support tools, 883, 902  
 development and, 882  
 disaster risk management, 871, 881-882  
 early adaptation, 878  
 early warning systems, 872, 877, 878, 883-885  
 in Europe, 1297  
 examples, 875, 875, 879-880, 880, 1355  
 facilitating, 888  
 factors constraining, 902  
 financing, 878-881, 902  
 governance, 25, 85-87, 887-889  
 horizontal interplay, 871  
 impacts-led approaches, 872  
 implementation, 390-392, 877-878, 879-880  
 implementation tools, 838  
 increasing capabilities, 888-889  
 indigenous communities, 876  
 information and communication technologies, 884  
 institutional dimensions, 871, 886-888  
 insurance, 872, 884, 885-886  
 international mechanisms, 873-874  
 learning processes, 871  
 levels of, 873-877  
 livelihoods and poverty and, 815-816  
 local governments, 871, 876  
 local knowledge, 875  
 mixed-portfolio approaches, 883  
 monitoring, modeling, and spatially integrated tools, 872, 883  
 multidisciplinary efforts, 872  
 multiple approaches to, 871-872

- multiple stresses and, 871  
 national initiatives, 85, 871, 874-875  
 planning tools, 883-885  
 political dimensions, 887-888  
 present status, global, 876  
 private sector, 8, 871, 876, 876, 880-881, 886, 948, 950  
 public sector, 8, 948, 950  
 research needs, 889-890  
 return on investment, 880-881  
 status and progress, 871, 873-881, 876  
 strategies and approaches, 871-872, 883-884  
 subnational initiatives, 85, 871, 875-877, 875, 881  
 technology development, 885  
 in terrestrial and inland water systems, 324-326  
 tools, 872, 883-886, 884  
 top-down and bottom-up approaches, 871-872  
 transboundary, Mekong River Basin, 1355  
 types of approaches, 871-872, 878  
 in urban areas, 539-540, 876-877
- Adaptation potentials.** *See* Adaptation opportunities, constraints, and limits
- Adaptive capacity\***, 838, 875, 1176-1178  
 assessment of, 214  
 building, 909, 1115-1116  
 in China, 1116  
 development and, 1111  
 exceedance of, 87  
 in food systems, 513-514  
 of indigenous peoples, 765, 766  
 limits to, 426  
 of ocean systems, 416  
 poverty and, 816  
 regional context, 1142-1144  
 resilience and, 217  
 in rural areas, 617  
 in small islands, 1617, 1636-1637  
 of societal actors and natural systems, 902  
 in urban areas, 179-180, 539  
*See also specific systems and regions*
- Aeroallergens**, 729, 1043
- Afforestation**, 233, 257, 284, 317, 321
- Africa, 1199-1265**  
 access to resources/technology, 1204  
 adaptation, 8, 51, 487, 1203-1204, 1225-1238, 1237-1238, 1240  
 adaptation and development linkages, 1203-1204  
 adaptation barriers, 1236-1238  
 adaptation deficit, 1203  
 adaptation experiences and lessons learned, 54, 1229-1236  
 adaptation limits, 1204, 1236-1238  
 adaptation opportunities, constraints, and limits, 21, 922  
 adaptive capacity, 1204, 1226  
 agricultural pests, diseases, and weeds, 1220  
 agriculture, 54, 519, 1203, 1212-1213, 1218-1221, 1223, 1231  
 air quality, 1224  
 biodiversity, 1231-1232  
 biofuels, 1240-1241  
 biome change, 1215  
 Botswana, 804  
 climate finance and management, 1241-1242, 1241  
 climate forecasts, 643  
 coastal and ocean systems, 388, 1216  
 communication, 1233  
 community-based adaptation, 1229  
 conclusions from previous assessments, 1205-1206, 1205  
 costs of climate impacts, 631  
 crop insurance, 1147  
 crop yields, 510, 1218-1219, 1219  
 Darfur, conflict in, 773  
 deserts/desertification, 1205, 1209, 1210, 1213, 1214, 1215, 1234  
 detection and attribution, 44, 1003-1009, 1005-1006, 1212  
 development pathways, 1203-1204  
 diseases, 1222-1224  
 droughts, 42  
 East Africa coast and Madagascar, 1688  
 ecosystem services, 1231-1232  
 ecosystems, 1202, 1213-1216, 1214  
 education, 1213, 1233  
 emerging issues, 1238-1242  
 environmental context, 1211-1212  
 equity, 1226, 1227  
 extreme temperature and rainfall, 1210-1211  
 extreme weather and climate events, 42  
 fisheries, 1220-1221  
 floods, 42, 804, 805  
 food insecurity, 512, 1203  
 food production, 1202, 1212-1213  
 food security, 1202, 1212-1213, 1218-1221, 1221  
 freshwater ecosystems, 1215-1216  
 governance, 1203, 1227-1229  
 hantavirus, 1224  
 health, 1221-1224  
 human health, 715, 1203  
 human population, 1203  
 human security, 1204, 1238-1239  
 ICPAC, 1157  
 impacts, 1211-1225  
 infrastructure, 1234-1235  
 insurance, 54, 1231  
 integrated adaptation/mitigation, 91, 1240  
 Intergovernmental Authority on Development (IGAD), 1157  
 key risks, 21, 76, 117, 1204, 1237-1238, 1238  
 Lagos flooding, 804  
 land use, 1240-1241  
 leishmaniasis, 1223  
 Limpopo River, 803  
 livelihoods, 1155, 1230-1231  
 livestock, 511, 1219-1220  
 maladaptation risks, 1203-1204, 1235-1236  
 malaria, 722-723, 723, 1222-1223  
 malnutrition, 1222  
 meningococcal meningitis, 1224  
 migration, 1239-1240  
 mitigation, 1237-1238, 1240  
 mixed farming in Tanzania, 519  
 monsoons, 1161-1162  
 multiple stressors, 1202  
 Nairobi Work Programme, 583  
 natural resource management, 1231-1232  
 observed changes, 30, 82, 848, 1206-1211, 1207, 1208  
 observed climate trends, 1206-1211  
 observed impacts, 44, 1003-1009, 1005-1006, 1202  
 perennial crops, 1202, 1219, 1219  
 policies and access to information, 635  
 poverty, 801, 1211-1212  
 poverty indicators, 624  
 precipitation, 82, 1202, 1207, 1208, 1209-1210  
 projected changes, 82, 1206-1211, 1207, 1208  
 projected impacts, 796, 1202, 1204  
 regions within, 1205  
 research gaps, 1204, 1242-1243, 1242  
 resilience in, 1204  
 Rift Valley fever, 1223  
 risk management/reduction, 1202, 1204, 1230-1231, 1237-1238  
 risks, 21, 73-75, 76, 117, 1204, 1237-1238, 1238  
 river flow, 143-144  
 Sahel region, 519, 777  
 schistosomiasis, 1223-1224  
 social justice, 1227, 1227  
 socioeconomic context, 1211-1212  
 sub-Saharan, 796, 801  
 sustainable development, 1226-1227  
 technology, 1204, 1234-1235  
 temperature, 82, 1202, 1204, 1206-1209, 1207, 1208, 1224  
 terrestrial ecosystems, 1213-1215, 1214  
 trees, integrating into cropping systems, 1231  
 tropical beverage crops, 626, 641  
 undernourishment, 1213, 1213  
 urbanization, 1224-1225  
 violent conflict, 1239, 1239  
 vulnerability, 1202-1203, 1211-1225  
 water resources, 73-74, 250, 250, 625, 1203, 1213, 1216-1218  
 water stress, 73-74, 1202, 1217, 1237, 1237
- Aggregate impacts\***, 690, 690  
 risks associated with, 12, 61, 1015, 1016, 1044, 1077-1078
- Agricultural droughts**, 232, 247-248, 247
- Agricultural productivity**, 60, 810-812
- Agriculture**  
 adaptation, 215, 277, 489, 514-516, 515, 516, 638, 639-640  
 adaptation options, economic evaluation of, 962  
 adaptation trade-offs, 918  
 in coastal systems, 384  
 conservation agriculture, 638  
 crop insurance, 54, 685, 1147  
 diversification of, 516, 638  
 economic dependence on, 616, 617  
 extreme events and, 503  
 high-value food crops, 625  
 human security and, 761, 762, 763, 766, 768-769  
 irrigation, 233, 241, 251, 257  
 land conversion for, 67  
 observed impacts, 996-997  
 post-harvest aspects, 623-625  
 projected changes, 488-489, 623-625, 810-812  
 rainfed, 251-252, 498, 499, 514, 616, 624, 634  
 in rural areas, 616, 617, 621-625  
 smallholder and subsistence, 503, 616, 623, 627, 634, 638, 797  
 soil erosion and, 233, 237-239, 246  
 temperature effects, 110  
 trade and, 617, 628-629  
 tropical beverage crops, 625, 626-627, 641, 1528  
 under-investment in, 616

- in urban areas, 539  
 valuation of changes, 617, 631-632, 632  
 water demand, 251-252, 625  
*See also* Crop yields; Food production systems
- Air pollution**, 713, 727-730, 728  
 acute episodes, 729  
 biomass burning, 739  
 black carbon, 716, 739  
 climate-altering pollutants, 713, 714, 715, 716, 728, 728  
 forest fires and, 721, 729  
 fuel combustion, 738-739  
 household sources, 738-739  
 human health and, 727-730, 737-738  
 outdoor sources, 738, 739  
 ozone, 728-729, 728  
 particulate, 728, 728  
 primary co-pollutants, 739  
 reducing, 737-740  
 secondary co-pollutants, 739-740  
 temperature and, 729-730  
 transboundary pollution, 1353
- Air quality**, 189, 727-730  
 fires and, 721, 729  
 human health and, 727-730  
 near-term future, 729-730  
 ozone and, 1171, 1172  
 projected changes, 729-730, 1171, 1172  
 regional projections, 1171, 1172  
 in urban areas, 556
- Air transportation**, 676
- Albedo**, 274  
 green and white roofs, 90, 574-575
- Algal blooms**, 253, 257, 454-455  
 dissolved inorganic carbon and, 287  
 harmful (HAB), 439-440, 454-455, 465, 726, 1582  
 toxins produced by, 251, 252
- Alien species**. *See* Invasive species and invasive alien species
- Allergens**, 1000, 1043, 1056, 1064-1065, 1465
- Alpine ecosystems**, 314-317, 1274, 1274, 1301
- Alternative development pathways**, 1044, 1052, 1072-1073
- Amazon region**, 64, 67, 1502, 1507, 1509-1510, 1518, 1519, 1542  
 abrupt and irreversible changes (potential), 64, 67, 276, 309-310, 1016  
 Amazon river, 1518, 1519, 1521, 1543  
 biomass in, 308, 989  
 deforestation, 276, 284, 310, 1502, 1503, 1509-1510, 1514-1515, 1514, 1522-1523, 1535  
 forests, 64, 67, 276, 284, 310, 982, 990-991, 1016, 1503, 1512, 1514, 1522-1523  
 observed impacts, 83, 982, 990-991  
 projected changes, 83  
 tipping point (potential), 64, 309-310, 1016
- Amphibians**, 275, 300, 989
- Anaerobic organisms**, 415, 443
- Andes region**, 1502, 1507, 1508, 1510, 1519, 1521, 1522
- Animals**  
 Arctic, 317, 990, 1016, 1570, 1575-1576, 1588, 1596  
 hypoxia and, 443  
 life cycles, 441  
 marine, 414, 429-430, 440-441, 443, 449-450, 457, 1575-1576, 1588-1589  
 multiple drivers, responses to, 447  
 phenology, 292  
 in polar regions, 317, 414  
 temperature and, 49, 447  
 thermal sensitivity/windows, 48, 49, 427-428, 427, 428, 429-430
- Annex 1 and 2 countries**, 1115
- Anoxia**, 415-416, 443-445
- Antarctic Circumpolar Current**, 1671
- Antarctica**  
 freshwater systems, 1573, 1586-1587  
 key risks and adaptation, 1594  
 ocean acidification, 1587  
 productivity and species, 1576-1577  
 Southern Ocean, 1585-1586, 1589  
 terrestrial ecosystems, 1581, 1590  
 tourism, 1595  
*See also* Polar regions
- Anthropogenic\* climate change**, 26, 982  
 DAI (*See* Dangerous anthropogenic interference)  
 drivers of, 1502  
*See also* Detection and attribution
- Aquaculture**, 452, 488, 676, 1701-1704  
 adaptation, 489, 516  
 in coastal systems, 366, 384  
 impacts, 366, 384, 500-501, 508, 676  
 ocean acidification and, 452  
 vulnerabilities, 500-501
- Aquifers**, 364, 379, 991  
*See also* Groundwater
- Arabian Gulf**, 1683
- Arabian Sea**, 1687-1688
- Aragonite**, 423, 1673, 1674, 1675, 1683
- Arctic region**, 1570, 1572  
 abrupt and irreversible changes (potential), 276, 1017  
 adaptation limits, 1570  
 animal populations, 1580-1581  
 cascading impacts, 1015-1016  
 compound risk, 1058, 1059  
 economic sectors, 1584-1595  
 economy, 1585  
 extreme weather events, 42  
 fisheries, 1584  
 freshwater ecosystems, 1572-1573, 1586, 1594  
 health impacts, 42, 1581-1583, 1594  
 hydrology, 1572-1573, 1586  
 indigenous peoples, 51, 983, 1016, 1581-1583, 1593-1595  
 infrastructure, 1584-1585, 1594  
 key risks and adaptation, 8, 1594  
 krill, 1577  
 livelihoods, 51, 983  
 marine mammals and seabirds, 1588-1589  
 marine transport, 1584  
 multiple stressors, 1572-1586  
 navigation and shipping, 559, 776, 776, 1173, 1174, 1584, 1591-1593, 1591, 1592, 1705  
 observed changes, 1572-1586  
 observed impacts, 232, 314, 982, 983, 990, 1017  
 ocean acidification, 1587  
 phenology, 1578, 1578, 1588-1589  
 as potential carbon source, 315  
 projected changes, 314-317  
 projected impacts, 1586-1593  
 rapid rate of change in, 1570  
 regime shift in, 1015-1016  
 resource exploration, 1585, 1593  
 river ice, 232  
 sea ice losses, 60, 623, 776, 982, 987, 987, 1015-1016, 1071, 1570, 1591, 1595, 1705, 1712  
 sea ice projections, 1136, 1591-1593  
 security and geopolitical issues, 776  
 socioeconomic impacts, 1595  
 terrestrial ecosystems, 1577-1581, 1589-1590  
 tipping elements, 276, 1015-1016, 1017  
 traditional knowledge, 8, 54, 1583-1584  
 trans-Arctic shipping, 453, 1584, 1705  
 transportation infrastructure, 628  
 as unique and threatened system, 1013, 1014  
 vegetation, 1578-1580, 1579  
 vulnerability, 1572-1593  
 warming in, 190, 776  
*See also* Polar regions
- Armed conflict**, 771-775, 772, 773
- Asia**, 75-76, 1327-1370  
 about: countries and regions included, 1332  
 adaptation, 8, 22, 51, 922, 1334-1352, 1336-1337, 1355  
 adaptation and mitigation interactions, 1352-1353  
 adaptation, mainstreaming and institutional barriers, 1351-1352  
 adaptation, valuation of, 1350-1351  
 agriculture, 75  
 biodiversity, 1342  
 case studies, 1355-1356  
 caste system, 799, 807, 808  
 coastal systems, 1341-1343, 1347, 1351, 1354  
 conclusions from previous assessments, 1332  
 conservation, 1351  
 coral reefs, 1342  
 crop areas, 1344-1345  
 crop failure, 1336, 1352  
 crop yields, 509, 1349  
 dams, 1342, 1345, 1353, 1355  
 deserts/desertification, 1330, 1339, 1344  
 detection and attribution, 45, 1003-1009, 1006  
 development, 1330, 1351  
 disaster preparedness, 148, 1350  
 diseases, 723, 723, 1348-1349  
 droughts, 1341, 1348  
 economic development, 1330, 1351  
 economic growth, 1351  
 economy, 1353  
 education, higher, 1352  
 equitable development, 1351  
 extreme weather events, 1330, 1331  
 fisheries and aquaculture, 1345  
 floods, 1348, 1351  
 food production and security, 1330, 1343-1346, 1344, 1349, 1354  
 forests/forestry, 1340  
 freshwater resources, 1334-1338, 1338, 1354  
 glaciers, 242, 243, 1337, 1356, 1357  
 human health, 715, 1331, 1347, 1348-1350, 1354  
 human population, 1332, 1347  
 human security, 1331, 1348-1350, 1354  
 human settlements, 1346-1348, 1354  
 hydropower, 1355  
 income inequality, 802  
 industry, 1330, 1346-1348  
 infrastructure, 1346-1348

- intra-regional and inter-regional issues, 1353  
 key risks, 22, 77, 118  
 livelihoods, 1331, 1348-1350, 1354  
 malaria, 723, 723  
 marine systems, 1330  
 migration, 1353  
 monsoons, 1333, 1334  
 multiple stresses, 1330  
 new coverage in AR5, 1333  
 observed climate change, 83, 1333-1334  
 observed impacts, 31, 45, 1003-1009, 1006, 1334-1351, 1336-1337, 1354  
 oceans, 1334  
 peatland, 258, 1341, 1350, 1352, 1353  
 permafrost, 1330, 1340, 1341, 1342  
 phenology, 1339, 1340  
 poverty, 624, 1331, 1348-1350, 1354  
 precipitation, 83, 1333, 1335  
 projected changes, 83, 796, 1330-1331, 1334  
 projected impacts, 74-75, 1334-1351, 1336-1337, 1354  
 research and data gaps, 1331, 1353-1354, 1354  
 rice, 41, 1330, 1343-1345, 1344, 1347, 1349, 1354, 1354, 1355  
 rice landscapes, 318  
 risk, 22, 77, 118, 1336-1337, 1347  
 risk management, 1351-1352  
 runoff, 1337-1338  
 sea level rise, 1342  
 species and biome distributions, 1339-1340  
 storm damages, exposure, and economic impacts, 147-148, 148, 1333-1334, 1638  
 surface wind speeds, 1334  
 sustainable cities, 91  
 temperature, 83, 1330, 1333, 1335, 1348  
 terrestrial and inland water systems, 1330, 1339-1341, 1354  
 trade, 1353  
 transboundary adaptation planning, 1355  
 transboundary pollution, 1353  
 tropical and extratropical cyclones, 147-148, 148, 1333-1334  
 urbanization, 1330  
 valuation of impacts and adaptation, 1350-1351  
 vulnerability, 1334-1351, 1336-1337  
 water resources, 250, 250, 1330, 1337-1338, 1346  
 water-saving irrigation, 1116  
 water scarcity, 1330, 1337-1338, 1338  
 water stress, 1338  
*See also specific countries*
- Assessment**, 3, 3-4, 37, 184, 198, 199, 213-214  
 of adaptation (*See* Adaptation assessment)  
 context for, 4, 38-39  
 of impacts (*See* Impact assessment)  
 stakeholder participation in, 837  
 of vulnerabilities (*See* Vulnerability assessment)  
*See also* Decision making; IPCC Assessment Reports
- Assessment methods**  
 downscaling, 211-212, 1137-1138, 1159-1162  
 risk assessment, 922  
 stakeholder involvement, 837  
 thresholds and risk criteria, 855, 1051-1052  
 top-down vs. bottom-up approaches, 851, 1144, 1144
- Atlantic Multi-decadal Oscillation/Variability (AMO/AMV)\***, 63, 420, 422, 433, 993, 1671
- Atlantic Ocean**  
 chlorophyll concentrations, 1660  
 North Atlantic, 621, 1678-1679  
 responses to temperature, 434-435  
 sea surface temperature (SST), 1658, 1665  
 subtropical gyres, 1695-1696
- Atmospheric circulation**, 190
- Atolls**, 775, 1616, 1618, 1619-1622, 1619, 1623, 1634  
*See also* Small islands
- Attribution**. *See* Detection and attribution
- Australasia**, 76, 1371-1438  
 adaptation, 51-54, 1374-1375, 1382-1387, 1410-1411  
 adaptation challenges, 1374, 1406-1407, 1412-1413  
 adaptation decision making, 1386-1387  
 adaptation examples, 8, 55, 1148, 1157, 1398-1399  
 adaptation-mitigation interactions, 1406-1410, 1408  
 adaptation opportunities, constraints, and limits, 23, 922, 1382-1385, 1383, 1406-1407, 1412-1413  
 adaptation options, 389, 391-392  
 adaptation planning, 51-54, 1374-1375, 1389-1390  
 adaptation, transformational, 1375, 1412-1413  
 adaptation, uncertainties and, 1386-1387  
 adaptive capacity, 1375  
 agriculture, 1157, 1374, 1376, 1396-1399  
 Australia, 1377, 1413  
 biodiversity, 1391, 1408  
 biosecurity, 1397  
 carbon sequestration/storage, 1409  
 climate change, 1374  
 coastal adaptation, 365, 389, 1384-1385  
 coastal and low-lying areas, 1374, 1375-1376, 1413  
 coastal ecosystems, 1392-1393  
 conclusions from previous assessments, 1377  
 coral reefs, 431, 1374, 1375, 1392-1393, 1395, 1413  
 crop yields, 511  
 cyclones, 1374, 1377, 1381  
 detection and attribution, 45, 1003-1009, 1006-1008  
 droughts, 721, 807, 1380, 1389, 1389, 1395  
 economy, 1374, 1379-1382, 1410, 1410-1411  
 ecosystems, 1374, 1375-1376, 1390-1393  
 El Niño Southern Oscillation (ENSO), 632, 1377  
 emerging risk, 1412  
 energy supply, transmission, and demand, 1374, 1400-1401, 1408  
 extreme heat, 721  
 extreme weather events, 721, 1374, 1380-1381  
 fires/wildfires, 721, 1374, 1375, 1381, 1400, 1408, 1413  
 fisheries, 1393  
 floods, 721-722, 1374, 1375, 1404  
 flow-on effects, 1408-1410  
 forestry, 1393-1396  
 freshwater resources, 1374, 1387-1390, 1388  
 gender impacts, 807  
 Great Barrier Reef, 431, 1393  
 heat waves, 1374, 1375, 1380, 1401, 1402, 1405, 1407, 1411, 1413  
 heat waves, Victorian, 42, 1374, 1400, 1401, 1402  
 human health, 1374, 1402-1405, 1408, 1413  
 human population, 1379  
 human systems/society, 1374, 1375, 1380-1381, 1402-1406, 1412  
 indigenous peoples, 1375, 1405-1406, 1408  
 industries, 1393-1401  
 industries, relocation of, 55  
 infrastructure, 1375, 1408, 1413  
 insurance, 1403  
 invasive species, 1397  
 Kakadu National Park, 1391  
 key risks, 23, 78, 118, 1375-1376, 1410-1413, 1410-1411, 1413  
 knowledge gaps, 1376, 1413-1414  
 land-based interactions, 1409  
 livelihoods, 1408  
 livestock, 511, 1396-1397  
 Maori (New Zealand), 1395-1396  
 marine ecosystems, 1392-1393  
 migration, human, 1375-1376, 1410  
 mining, 1399, 1408  
 mortality from drought, fires, and heat waves, 42, 721  
 mountains/montane ecosystems, 1375, 1381, 1401, 1411, 1413  
 Murray-Darling Basin, 807, 843, 1374, 1376, 1379, 1389, 1410  
 native species, 1375  
 natural systems/ecosystems, 1375, 1390-1393, 1394-1395, 1412  
 New Zealand, 1377, 1413  
 observed climate change, 83-84, 1374, 1377-1379, 1378-1381  
 observed impacts, 31, 45, 1003-1009, 1006-1008, 1385-1387, 1394-1395  
 ocean acidification, 1374, 1379, 1393, 1413  
 poverty, 1379-1382  
 precipitation, 83-84, 1374, 1377-1379, 1378, 1380  
 productivity (vegetative), 1374, 1376  
 projected climate change, 83-84, 1374, 1377-1379, 1378-1381  
 projected impacts, 76, 1375-1376  
 relocation of agricultural industries, 1148  
 risk management/reduction, 1403, 1410-1411, 1412-1413  
 rural areas, 1398-1399, 1408  
 sea level, 1374, 1376, 1381, 1384, 1413  
 snow and ice, 1381  
 sociocultural factors, 1376, 1379-1382  
 socioeconomic scenarios, 1382  
 species distribution and viability, 1390-1392, 1394-1395, 1397  
 synergies and trade-offs, 1376, 1409  
 temperature, 83-84, 1006-1008, 1374, 1377, 1378-1380, 1402-1403, 1402, 1410-1411  
 terrestrial ecosystems, 1390-1392  
 tourism, 1401, 1408  
 transboundary effects, 91  
 urban adaptation, 1406-1407  
 vulnerability/risk, 76, 1374, 1375-1376, 1385, 1391, 1393, 1410-1413, 1410-1411, 1413  
 water conservation, 1374, 1389-1390  
 water management, 1389-1390, 1408

- water resources, 1374, 1374-1375, 1387-1390, 1388, 1399
- Autonomous adaptation\***, 321-324, 815  
in Central and South America, 1531, 1538-1539  
in Europe, 1284-1286  
in North America, 1472-1473
- Avalanches**, 989, 1280
- Avoided impacts**, 1045, 1081-1083, 1081
- B**
- Bacterial pathogens**, 726
- Baltic Sea**, 80, 1684
- Bangladesh**  
adaptation and disaster risk reduction, 148, 910  
coastal regions, 804  
cyclone impacts, 148  
exposure to storm damages, 1638  
flood protection costs, 673  
floods, 105, 1346  
gender roles in, 105  
human population, 373  
rice prices, 568  
*See also* Asia
- Barents Sea**, 1678
- Baseline/reference\***, 138, 1179-1181
- Beaches**, 375-376  
erosion, 1524, 1525, 1620, 1624  
recreational value, 663, 679  
*See also* Coastal systems and low-lying areas
- Benguela Current**, 1691-1692
- Benthic habitats and ecosystems**, 125, 150, 422, 424, 443-444, 448, 449
- Bering Sea**, 1576
- Biodiversity\***  
adaptation, 640-642  
adaptation trade-offs, 918  
adaptive management, 101, 640-642  
in Africa, 1231-1232  
in Australasia, 1391, 1408  
in Central and South America, 1502, 1522, 1535, 1542  
in coastal systems, 376-377  
coral reefs, 1016  
in Europe, 1289, 1294-1295, 1297, 1299-1300, 1300, 1304  
forest dieback and, 276  
habitat for, 319-320  
hotspots, 1177  
invasive species and, 289  
key risks, 1042, 1058, 1071  
mitigation and, 1043, 1061-1062  
nitrogen deposition and, 286  
in North America, 1446, 1458-1462, 1460, 1475  
observed impacts, 990  
in ocean systems, 416, 451, 453, 461  
in small islands, 1622  
in terrestrial and freshwater ecosystems, 274, 277  
vulnerability/risk, 60-62, 63, 274  
*See also* Extinction; Range shifts
- Bioenergy\***, 318  
unintended consequences of, 277, 327
- Bioenergy crops**, 320  
land use for, 277  
water needs, 233, 257
- Biofuel production**, 320, 617, 1043, 1409  
in Central and South America, 1515, 1533-1534, 1535, 1544-1545
- impacts of, 630  
land use and, 630, 797, 806-807, 814-815  
palm oil, 1515, 1533  
risk and emergent risks, 1055-1056, 1056, 1118  
water for, 163, 630
- Biological systems**. *See* Ecosystems
- Biomass\***  
biomass stove programs, 739, 1353  
combustion fuels, 738-739  
observed impacts, 989-990  
phytoplankton, 434-435, 445
- Biomass burning**, 739
- Biomass-derived energy**, 320
- Biomes\***, 446  
biome changes (Africa), 1215  
biome shifts, 274, 278-279, 279, 280, 281, 316-317  
*See also* Ecosystems; Range shifts
- Biophysical adaptation needs**, 840-841
- Biophysical processes**, 278, 283-285, 1043
- Birds**  
phenology and, 321-322  
seabirds, 414, 449-450, 457, 1575, 1577, 1588-1589
- Black carbon**, 716, 739
- Black Sea**, 80, 1684
- Blue Carbon**, 394, 1699-1701
- Body size**, 414, 428, 429, 430, 458, 459
- Bogs**, 313
- Bohai Sea**, 1686-1687
- Boreal forests**, 303-305, 317, 982, 1016, 1589
- Boreal-tundra Arctic systems**, 67, 1589-1590  
biome shift, 316-317  
productivity in, 990  
spring advancement, 292  
tipping point (potential), 64, 276, 316-317, 1016  
vulnerability of, 303-305
- Bottom-up approaches**, 851, 871-872, 1144, 1144
- Boundary organization\***, 207, 392
- Brazil**  
agriculture, 1503, 1527  
allocating tax shares, 589  
deforestation, reduction in, 1522-1523  
energy production, 1533-1534, 1540  
fisheries, 1503  
observed and projected changes, 83  
payment for ecosystem services (PES), 1541  
precipitation, 83, 1502, 1503  
rainfall, 1502  
renewable energy production, 1533-1534  
S„o Paulo, 1532  
species changes, 1502  
temperature, 83  
*See also* Central and South America
- Breeding programs**, 326
- Brundtland Report**, 1118
- Bryozoans**, 442
- Built environment\***, 27, 538, 559-560  
adaptation options, 845, 846
- C**
- C<sub>3</sub> plants**, 288, 310-311, 500
- C<sub>4</sub> plants**, 287, 288, 311, 500, 505
- Calcifiers**, 17, 64, 364, 366, 372, 374, 436-437, 436, 441, 447, 452, 464-465, 1064  
*See also* Ocean acidification
- California Current**, 1692
- Campylobacter**, 726
- Canada**, 1446-1447  
adaptation, 1474, 1475  
adaptation constraints, 1445, 1448  
agriculture and food security, 1462  
climate projections, 1455-1456  
climate trends, 1453-1454  
detection and attribution, 1447  
extreme events and vulnerabilities, 1450, 1470  
forests, 294, 320  
GDP, 1451  
human health, 1464-1466  
human population, 1448-1449, 1451, 1452  
mining, 1467-1468  
NAFTA, 1448, 1450  
precipitation, 81  
snowpack and snowmelt, 81, 1443, 1470  
socioeconomic indicators, 1451  
temperature, 81  
tourism and recreation, 678  
transportation infrastructure, 628  
tree mortality, 1459  
Vancouver, climate responses, 1474  
water resources, 1443-1444, 1456-1457  
wildfires, 1460-1461, 1473  
winter precipitation, 1454  
*See also* North America
- Canary Current**, 1690-1691
- Cancun Agreements (2010)**, 814, 853
- Capacity building\***, 909, 1115-1116  
*See also* Adaptive capacity
- Capacity needs\***, 838-839, 844
- Carbon**  
Blue Carbon, 394, 1699-1701  
dissolved organic (DOC), 287, 313  
social cost of (SCC), 690-691, 691  
storage (*See* carbon sequestration; carbon sinks)  
voluntary carbon offsets, 814
- Carbon capture and storage (CCS)**  
deep sea, 1705-1706  
effects on freshwater resources, 233, 258  
transport of CO<sub>2</sub>, 668
- Carbon cycle\***, 287, 293
- Carbon dioxide (CO<sub>2</sub>)\***  
carbon dioxide fertilization\*, 286, 293, 328  
effects on ecosystems, 287  
effects on human health, 1043, 1064-1065  
effects on ocean systems, 415, 418, 432-443, 450  
effects on plant growth, 157, 159, 293, 303, 308  
FACE (Free Air CO<sub>2</sub> Enrichment) studies, 287, 495, 499  
flux, in oceans, 420, 993, 1660  
freshwater resources and, 251  
plant productivity and, 276, 292-293  
pollen production and, 1043  
rise in, 287-288  
rising concentrations of, 287-288  
transfer from atmosphere to land, 276
- Carbon dioxide fertilization\***, 286, 293, 328
- Carbon Dioxide Removal (CDR)**, 454
- Carbon monoxide**, 739
- Carbon sequestration**  
climate change effects on, 276  
by forests, 90, 276  
by mangrove forests, 90, 1155  
mitigation efforts by planting trees, 277

- by terrestrial and freshwater ecosystems, 275-276, 277  
 See also Carbon capture and storage; Carbon sinks
- Carbon sinks**, 15, 64, 67  
 in the Arctic  
 global carbon stores, 313-314  
 loss of, 1054  
 peatland changes and, 313-314  
 reversal to carbon source (potential), 67, 276, 313-314, 315  
 terrestrial ecosystems, 64, 275-276, 293-294, 989
- Carbon stocks**, 293-294, 394, 1016
- Carbonate chemistry**, 130, 414, 436, 436, 464, 1658, 1673-1675
- Carbonate neutralization**, 454, 455
- Caribbean region**  
 Caribbean Catastrophic Risk Insurance Facility, 886, 1638  
 Caribbean Sea, 1688  
 climate projections, 1628  
 dengue fever, 724  
 ocean swells, 1631  
 sea urchin (*Diadema*) in, 1633-1634  
 See also Small islands
- Caribou**, 1580
- Cascading impacts**, 64, 983, 1012, 1013, 1015-1016
- Caste system**, 799, 807, 808
- Cattle**. See Livestock
- CDM**. See Clean Development Mechanism
- Central and South America**, 78-80, 1499-1566  
 adaptation, 8, 91, 1516-1537, 1545  
 adaptation, autonomous and planned, 1531, 1538-1539  
 adaptation, barriers to, 1539  
 adaptation, ecosystem-based, 54, 1502, 1542  
 adaptation experiences, 1538-1539  
 adaptation, first step in, 1502, 1531, 1545  
 adaptation interactions with mitigation, 1539-1540  
 adaptation opportunities, constraints, and limits, 24, 922, 1537-1539  
 adaptive capacity, 1508, 1531, 1537  
 agricultural productivity, 1503, 1528-1529, 1543  
 agriculture, 1502, 1503, 1504, 1514-1515, 1527-1531, 1528-1529, 1543  
 air quality, 1536-1537  
 Amazon forest, 276, 284, 310, 1502, 1503, 1509-1510, 1512, 1514-1515, 1514, 1522-1523, 1535  
 Amazon region, 83, 1502, 1507, 1509-1510, 1518, 1519, 1542  
 amphibians, 275  
 Andean cryosphere, 1502, 1517-1518, 1522  
 Andes region, 1502, 1507, 1508, 1510, 1519, 1521, 1522  
 beach erosion, 1524, 1525, 1541  
 biodiesel, 1533  
 biodiversity, 1502, 1522, 1535, 1542  
 biofuel production, 1515, 1533-1534, 1535, 1544-1545  
 case studies, 1540-1541  
 Central America, 1504  
 Chagas disease, 1536  
 cholera, 1536  
 climate change perceptions, 1508  
 climate extremes, 1505-1507, 1508  
 climate trends, 1502, 1506-1516, 1545  
 climate variability, 1502, 1506-1510, 1508, 1542  
 climatic stressors, 1506-1513  
 coastal systems, 1503, 1524-1527, 1525, 1541, 1543  
 coffee, 1528  
 community cooperatives, 1539  
 conclusions, 1542-1545, 1545  
 conservation, 1523-1524, 1526-1527  
 coral reefs, 1503, 1525, 1527, 1543, 1545  
 costs of extreme events, 805  
 crop yields, 510, 1504, 1527-1530, 1528-1529, 1543  
 cutaneous leishmaniasis, 1536  
 data and research gaps, 1541-1542  
 deforestation, 276, 284, 310, 1502, 1503, 1509-1510, 1514-1515, 1514, 1522-1523, 1535, 1540  
 dengue fever, 1535-1536  
 detection and attribution, 46, 1003-1009, 1544  
 diseases and vectors, 1503, 1532, 1532, 1535-1536, 1536, 1543, 1545  
 droughts, 247, 1545  
 early warning systems, 1538, 1545  
 economy, 1504, 1516, 1516  
 ecosystem loss, 1502, 1522  
 ecosystems, 1502, 1503, 1525-1527, 1542  
 El Niño Southern Oscillation (ENSO), 632  
 extreme events, 805, 1502, 1504-1505  
 fisheries, 1503, 1526  
 fishing agreements, 1542  
 floods, 1524, 1525, 1525, 1532, 1532, 1545  
 food production, 1503, 1527-1531, 1528-1529, 1544, 1545  
 food security, 1503, 1530, 1541, 1544-1545  
 freshwater resources, 1516-1522, 1517-1518, 1519-1520  
 glaciers, 623, 1518-1520, 1519, 1521, 1522, 1543, 1543  
 hantaviruses, 1536  
 heat waves, 1536, 1537  
 hotspots, 1530  
 human health, 1503, 1535-1537, 1536, 1545  
 human settlements, 1531-1533  
 hurricanes, 1508, 1535, 1542  
 hydropower, 1519-1520, 1540-1541, 1544  
 insurance, 1531  
 key risks, 24, 79, 119, 1545  
 La Plata River basin, 1502, 1507-1508, 1521, 1525, 1543  
 land management, 1527  
 land use/land use change, 1502, 1503, 1509-1510, 1513-1516, 1522-1523, 1534-1535, 1542, 1543  
 leptospirosis, 1532, 1536  
 livestock/cattle, 512, 1515, 1528, 1530  
 local and indigenous knowledge, 1531  
 low-lying areas, 1504-1527  
 malaria, 1535  
 mangroves, 1503, 1525-1526, 1527  
 manufacturing, 1532-1533  
 marine ecosystems, 1503, 1525-1527  
 marine protected areas, 1526  
 megacities, 1532, 1537  
 monsoons, 1506, 1509, 1511  
 mortality from extreme events, 805  
 non-climatic stressors, 1513-1516  
 observed changes, 82-83, 1502, 1505-1507, 1506-1510, 1543  
 observed impacts, 32, 46, 1003-1009, 1505-1507, 1516-1537  
 palm oil, 1515, 1533  
 payment for ecosystem services (PES), 1523, 1540-1541, 1541  
 phenology, 1523  
 plant pests and diseases, 1504  
 poverty, 1502-1503, 1515-1516, 1516, 1533  
 poverty indicators, 624  
 precipitation, 82-83, 1502, 1504, 1505-1507, 1509-1513, 1527, 1543, 1545  
 precipitation extremes, 1505-1507, 1545  
 previous assessments, 1502, 1504-1506, 1542  
 projected changes, 82-83, 1502, 1509-1513, 1510-1513  
 projected impacts, 1516-1537, 1519-1520  
 protected areas, 1524, 1526  
 recent changes and projections, 1506-1516  
 reforestation, 1540  
 regional and international partnerships, 1542  
 regional observed changes, 1505-1507, 1543  
 regional projected changes, 1509-1512, 1519-1520  
 regions within, 1505-1507  
 renewable energy, 91, 1503, 1533-1535, 1534, 1544-1545  
 risk, compound, 1532  
 risk reduction, 1531, 1538-1539  
 S.,o Paulo, 1532  
 schistosomiasis, 1536  
 sea level rise, 1503, 1504, 1541, 1543-1544  
 sea ports, 1524, 1525  
 socioeconomic conditions, 1502-1503, 1515-1516, 1516  
 South America, 1504  
 soy, 1503, 1504, 1515, 1527, 1528, 1535  
 species viability and range shifts, 1502, 1504, 1523  
 streamflow, 1502  
 sugarcane, 1503, 1528, 1533, 1534, 1540, 1544  
 temperature, 82-83, 1502, 1504-1505, 1505-1507, 1509-1513, 1543, 1545  
 temperature extremes, 1505-1507, 1545  
 terrestrial systems, 1522-1524  
 urban heat islands, 1532, 1533  
 urban settlements, 1531-1533, 1532, 1544  
 vulnerability, reducing in present, 1503  
 vulnerability/risk, 1502-1503, 1504, 1508, 1516-1537, 1532, 1537, 1545, 1545  
 water-borne diseases, 1532, 1532  
 water management, 1530-1532  
 water resources, 1502, 1516-1522, 1517-1518, 1519-1520, 1543, 1545  
 water supply, 1502, 1516, 1521-1522, 1543, 1544  
 yellow fever, 1536
- Cereals and grains**, 488, 491, 492, 497-499, 498  
 in Central and South America, 1527-1530, 1528-1529  
 in Europe, 1271, 1284, 1300
- Certainty**, 6, 7, 41
- Chagas disease**, 1536
- Change**  
 abrupt changes, 16, 63, 64, 67, 276, 421-423  
 institutional change, 1114  
 irreversible (See tipping points)  
 land use (See Land use change)



- Chikungunya fever**, 385, 723, 725, 736
- Child mortality**, 688
- Childhood undernutrition**, 731
- China**, 1332
- adaptive capacity in, 1116
  - coastal areas, 373
  - droughts, 1350
  - economic impacts, 1350-1351
  - exposure to storm damages, 1638
  - flood risk/adaptation, 24, 1346
  - forests, 1340
  - human health, 1347, 1349, 1353
  - income inequality, 802
  - precipitation, 1333
  - rice yields, 1343-1344
  - schistosomiasis, 727, 727
  - surface wind speeds, 1334
  - temperature, 1332, 1339
  - trade, 1353
  - transboundary pollution, 1353
  - typhoon-related losses, 682
  - water resources, 1337-1338
  - water-saving irrigation, 1116
  - See also* Asia
- Cholera**, 415, 455, 726, 1536
- health care costs, 689
  - shellfish and, 726
  - in small islands, 1624
  - Vibrio cholerae*, 455, 726
- Ciguatera fish poisoning**, 455, 1624-1625, 1634
- Circulation**
- atmospheric, 190
  - oceanic, 1658, 1671
  - regional, 1162
- Cities**. *See* Urban areas
- Clean Development Mechanism (CDM)\***, 797, 813-814, 1111
- afforestation/reforestation, 257
  - developing countries, 848-849
- Climate-altering pollutants (CAPs)\***, 713, 714, 715, 716, 728, 728
- Climate change\***, 3
- amplification of risks, 1057
  - commitment, 179
  - communication of understanding and risks, 171
  - core concepts and definitions, 3, 3-4, 5, 37-40, 85
  - detection and attribution of, 42, 979-1037
  - as driver of ecosystem changes, 256
  - impacts (*See* Impacts)
  - inaction, consequences and costs of, 326-327, 326
  - land use change and, 282
  - literature authorship, 38, 171
  - literature on, amount of, 38, 171, 172
  - magnitude and rate, adaptation and, 1121
  - observed impacts, 979-1037
  - perceptions of, 764, 1505-1507
  - Reasons for Concern, 12, 61, 983, 1013-1016, 1073-1080
  - as threat to sustainable development, 816, 1104, 1108-1113
  - uncertainty and, 254-255
  - See also* Climate velocity; *specific regions and systems*
- Climate change scenarios**. *See* Scenarios
- Climate extremes**. *See* Extreme weather events
- Climate forecasting**, 643
- Climate models\***
- CMIP3 and CMIP5\*, 137-138, 178, 179, 240, 1143, 1454
  - downscaling, 1137-1138, 1159-1162
  - Earth System Models (ESMs)\*, 282, 456
  - Global Climate Model (GCM), 370
  - ocean systems, 456-460, 457
  - regional, 1136, 1137-1138
  - Regional Climate Model (RCM), 370, 1162
- Climate policy**, 89-90, 171, 909, 922, 948-949
- culture and, 764
  - information for decision making, 171, 210-213
  - mainstreaming, 948
  - See also* Adaptation; Governance/government; Mitigation
- Climate regulation**, 453, 456
- Climate-resilient pathways**. *See* Resilience: Climate-resilient pathways
- Climate scenarios\***. *See* Scenarios
- Climate sensitivity\***, 423-424, 450, 997
- Climate system\***
- dangerous anthropogenic interference with, 11, 1043-1044, 1047, 1049, 1073
  - human interference with, 3, 12, 37, 61-62
- Climate variability\***, 414, 419, 450
- human health and, 717-720
  - impacts of, 6
  - modes of\*, 1162, 1180
  - net primary production and, 133
  - Ocean (region), 1658-1659, 1713
  - violence/conflict and, 1001-1002
- Climate velocity\***, 15, 62, 67, 125, 126, 274, 296, 297
- Climatic drivers\***, 240, 256
- in coastal systems, 364, 367, 368, 370-372
  - land use change, 274
- CMIP3 and CMIP5\***, 178, 179, 1143, 1454
- regional assessments (CMIP5), 1143
  - regional projections (CMIP5), 137-138, 1159, 1159
  - See also* Climate models
- Coastal squeeze\***, 375, 376, 378, 1623
- Coastal systems and low-lying areas**, 17, 69, 361-409
- adaptation and risk management, 365, 386-396
  - adaptation costs and benefits, 17, 364
  - adaptation decision making and governance, 388-390, 389
  - adaptation implementation and practice, 390-392
  - adaptation measures, 387-388
  - adaptation opportunities, constraints, and limits, 922
  - adaptation options, economic evaluation of, 962
  - adaptation planning, 387
  - adaptation, successful projects, 365
  - adaptation trade-offs, 918
  - adaptive capacity, 373
  - agriculture, 384
  - aquaculture, 366, 384, 500-501
  - aquifers, 364, 379, 991
  - beaches, barriers, and sand dunes, 375-376
  - biodiversity, 376-377
  - carbon stocks, 394
  - climate change and, 374, 376
  - climate-related drivers, 364, 367, 368, 370-372
  - community-based adaptation, 390, 391
  - coral reefs, 378-379, 378
  - costs and socioeconomic aspects, 373, 382, 383
  - decision making for, 211
  - definition, 366-367
  - deltas, 147-148, 369, 380-381
  - detection and attribution, 386, 386, 989-991, 1007-1008
  - developed vs. developing countries, 364-365
  - drivers of change, 364, 367-374, 367, 368
  - erosion, 7, 17, 44-46, 69, 364, 376, 381, 386, 991
  - estuaries and lagoons, 379-380, 991
  - eutrophication, 364, 373, 380, 420, 465
  - exposure, 364, 372-373, 381
  - extreme events, 385
  - fisheries, 384
  - global mean sea level rise, 364, 366
  - groundwater, 246
  - habitat destruction, 375, 1707
  - human health, 385-386
  - human impacts, 364, 366, 375
  - human migration to, 373, 805
  - human population in, 17, 364, 372-373, 381, 386
  - human-related drivers, 372-374
  - human settlements and infrastructure, 364, 381-383, 382, 993
  - human systems, 381-386
  - hypoxia, 373, 420
  - impact and risk assessment approaches, 374-375
  - impacts, 364, 374-386, 375, 982, 991-993
  - industry, infrastructure, transport, and network industries, 383-384
  - information gaps, data gaps, and research needs, 363-366
  - infrastructure, 364, 383-384, 993
  - Integrated Coastal Zone Management (ICZM), 365, 366, 878
  - inundation, 374, 1707, 1712
  - invasive species, 364
  - key risks and vulnerabilities, 59, 1070
  - local sea level, 364
  - Low Elevation Coastal Zone (LECZ), 372
  - natural systems, 375-381
  - nutrients, 364, 373, 380
  - observed impacts, 7, 30-32, 48, 991-993, 1007-1008
  - ocean acidity and, 364, 368, 370, 372, 374
  - ocean temperature and, 364, 371-372, 379
  - planned retreat, 387, 389, 1375-1376
  - progress since AR4, 366, 368
  - protection, 364, 371, 387, 395
  - regional differences, 382
  - regional sea level, 364, 369
  - rocky coasts, 376-377, 992
  - runoff changes and, 364, 368, 372
  - salinity levels, 370, 379, 993
  - scenarios and models, 367
  - sea level extremes, 370, 991, 993
  - sea level rise, 7, 17, 364, 366, 367-370, 368, 374, 375, 379, 381, 385, 1669-1670, 1707
  - sea level rise, long-term commitment to, 394-395
  - sea surface temperature, 368, 371-372, 431
  - sediment amounts and distribution, 364, 369, 373-374, 379, 380
  - socioeconomic development, 372-373

- species abundance, distribution, and range  
shifts, 364, 376, 377, 378, 982
- storm surge, 147, 148, 364, 370, 381, 453
- storms, 364, 368, 370
- submergence/subsidence, 364, 368, 369, 374
- tourism and recreation, 364, 384-385
- upwelling, 149-152, 150, 364, 373, 994
- urban flooding in, 722
- vulnerabilities and risks, 60-62, 69, 364,  
372-386, 453, 462-463, 1347
- wetlands and seagrass beds, 373, 377-378,  
992, 1330
- winds and waves, 368, 371
- See also specific regions and countries*
- Co-benefits\***, 28, 89-91, 180, 737-741, 742
- of adaptation, 89-91, 538, 578-579, 948, 1118
- coastal areas, 393
- of development, 948
- human health, 714, 737-741, 737, 738
- of integration of adaptation and mitigation,  
1104
- of mitigation, 714, 737-741, 737, 738, 742
- trade-offs and, 1119
- in urban areas, 538, 578-579
- Coccolithophores\***, 428, 440, 1681
- See also* Phytoplankton
- Cocoa**, 626-627
- Cod**, 461
- Coffee growing/production**, 506, 625, 626-627,  
1528
- Cold-related mortality**, 721, 983
- Commercial sectors**, 662, 671
- Communicable diseases\***. *See* Infectious diseases
- Communication tools**, 883
- Community-based adaptation\***, 390, 391,  
580-582, 582, 641, 1157
- adaptation experience, 53
- in small islands, 1146
- Compound risk**, 1042, 1057-1059, 1058, 1412
- Computable general equilibrium (CGE) model**,  
671, 689, 1059
- Confidence\***, 7, 177, 184-185, 186
- degree of certainty, 6, 7, 41
- See also* Uncertainty; *specific topics and  
executive summaries*
- Conflict**. *See* Violence and conflict
- Conservation**, 674, 1176
- conservation agriculture, 638
- ex situ*, 326
- Construction**, 27, 677
- traditional methods, 1637
- Copenhagen Accord**, 1115
- Coral bleaching\***, 80, 98, 364, 378, 1621, 1689
- detection and attribution, 982, 992, 1014,  
1014
- observed impacts, 378, 378, 414, 982, 992,  
1014, 1014
- projections, 457, 465, 1628, 1659
- temperature and, 379, 457, 1689
- Coral reefs**, 97-100, 378-379, 431
- adaptation potential, 431
- in Asia, 1342
- in Australasia, 431, 1374, 1375, 1392-1393,  
1395, 1413
- biodiversity, 1016
- in Central and South America, 1503, 1525,  
1527, 1543, 1545
- compound risk, 1058, 1059
- Coral Reef Provinces (of Ocean), 1667, 1669
- cross-chapter box, 97-100
- degradation of, 1690
- economic impacts, 131
- emergent risks, 1054, 1058
- food production, 493, 1690
- geographic locations, worldwide, 1689
- Great Barrier Reef, 431, 1393
- habitat loss, 414
- interactive effects on, 416
- Mesoamerican Coral Reef, 1503, 1525
- observed impacts, 378, 982, 992, 992, 1014,  
1014
- ocean acidification and, 16, 17, 98, 129, 131,  
364, 368, 415, 436, 438, 1064, 1065
- potentially irreversible changes, 1017
- projected impacts, 16, 379, 457, 1659
- recreation and tourism value, 384
- responses to climate change, 414
- sea level rise and, 378
- services provided by, 99
- small islands and, 1616, 1621, 1628, 1635
- thermal stress, 63, 110, 1669
- vulnerability/risk, 63, 97, 364, 415, 1064, 1065,  
1075
- See also* Coral bleaching
- Corals**
- calcification of, 99, 436, 441, 1042, 1064, 1065
- coral regions, 1689
- ocean acidification and, 364
- temperature and, 431, 457
- vulnerability/risk, 64, 1016
- warm- and cold-water corals, 16, 68, 431, 438,  
441, 465, 1014
- Core concepts and entry points**, 3, 3-4, 85
- Corporations**, 566, 836
- Cost-benefit analysis**, 948, 956-957, 963
- See also* Adaptation costs and benefits
- Cost of Policy Inaction (COPI) Projects**, 326-327
- Costs**
- adaptation (*See* Adaptation economics)
- coastal systems, impacts, 382, 383
- computable general equilibrium (CGE) model,  
671, 689
- extreme weather events, 633, 805, 982, 998,  
1016
- freshwater resources/management, 233
- global adaptation costs, 949, 959-960, 959,  
960
- health care, 687-689, 737
- residual cost, 952-953, 953
- social cost of carbon, 690-691, 691
- valuation of impacts, 617, 630-633, 632
- Crop insurance**, 54, 685, 1147
- Crop production**, 488-489, 491-493
- adaptation, 514-516, 514
- carbon dioxide effects, 487, 488, 507
- detection and attribution, 996-997
- emergent risks, 1059-1060
- models, 496
- observed impacts, 996-997
- ozone effects, 488, 493
- risks and vulnerabilities, 494-505
- See also* Food production systems
- Crop yields**, 17-18, 18, 65, 488-489, 491-493, 492,  
997
- adaptation and, 514-516, 515, 516, 519
- aggregate impacts, 1016
- carbon dioxide effects on, 487, 488, 493, 494,  
499, 506
- cereals and grains, 488, 491, 492, 497-499,  
498, 621
- climate extremes and, 796
- emergent risks, 1054
- observed impacts, 4-6, 7, 491-493, 492, 616,  
982
- ozone effects on, 488, 493
- pests, weeds, and diseases, 500, 506-507
- projected impacts, 17-18, 18, 69-70, 70,  
505-507, 505, 506, 509-511, 623-624
- rural areas, 616, 629
- sensitivity to climate and weather, 497-502,  
504-505, 504
- temperature and, 488, 492-493, 492, 497-499,  
498, 516
- trade and, 629
- See also* Agriculture; Food production systems;  
*specific regions*
- Cross-chapter boxes**, 97-166
- coral reefs, 97-100
- ecosystem-based adaptation, 101-103
- gender and climate change, 105-107
- heat stress and heat waves, 109-111
- key risks and vulnerabilities, emergent risks,  
and hazards, 113, 114-121
- long-term resilience, 147-148
- marine biogeography, abundance, and  
phenology, 123-127
- net primary production in the ocean, 133-136
- ocean acidification, 129-131
- regional climate summary figures, 137-141,  
138-140
- river flow regimes, 143-146
- tropical cyclones, 147-148
- upwelling ecosystems, 149-152
- urban-rural interactions, 153-155
- vegetation and water flows, 157-161
- water-energy/feed/fiber nexus, 163-166
- Crustaceans**, 16, 68, 415, 438, 465
- Cryosphere\***
- Andean, 1502, 1517-1518, 1522
- detection and attribution, 982, 986-989, 987
- observed impacts, 982, 986-989, 987, 1003
- regional impacts, 1003
- See also* Polar regions
- Cultural and organizational theory**, 198, 204, 272
- Culture**
- adaptation and, 762-765, 764
- climate impacts and, 762-765, 764
- climate policy and, 764
- cultural constraints to adaptation, 915-916
- cultural landscapes, 318
- cultural services, oceans, 453
- cultural values, 71-72, 203-204
- human security and, 71-72, 758, 762-766, 764
- Cyanobacteria**, 439-440, 726
- Cyclones**. *See* Extratropical cyclones; Tropical  
cyclones
- D**
- Dams**, 275, 327, 1061-1062
- in Asia, 1110-1111, 1342, 1345, 1353, 1355
- in Egypt (Aswan High Dam), 252
- in USA, 1458
- in Vietnam, 1110-1111, 1355
- Dangerous anthropogenic interference (DAI)**, 11,  
1043-1044, 1047
- Article 2 (UNFCCC), 1047
- definition of, 1049, 1073

- Dansgaard-Oeschger (DO) events**, 421-423
- Dar es Salaam**, 591-592
- Darfur, conflict in**, 773
- Dead zones\***, 17, 373, 415, 420, 1676, 1693, 1709-1710
- Deaths**. See Mortality
- Decision making**, 9-11, 54-56, 195-228
- adaptation, mitigation, and sustainable development—linkage of, 216-218, 217, 388-390, 638, 1118
  - approaches, 199-200
  - assess-risk-of-policy framing, 208
  - assessment of impact, adaptation, and vulnerability, 213-214, 213, 837
  - behavioral sciences, 198, 199, 204
  - climate and climate change decisions, 200, 210, 214-216, 216
  - climate impacts, adaptation, and vulnerability, 204-214, 213
  - complexity in, 200-201
  - context for, 9-11, 54-56, 203-207
  - cultural and organizational theory, 198, 204, 272
  - cultural values, 199, 202, 203-204
  - decision analysis, 212
  - decision implementation, 212
  - decision review, 212
  - decision scoping, 212
  - downscaling, 211-212
  - economic barriers to, 955-956
  - in economic context of adaptation, 954-958, 954
  - economic evaluations as support for, 948
  - ethics, 198, 205-206
  - four-stage process of, 212
  - frameworks for, in ocean regions, 1661, 1711-1713, 1711-1712
  - geo-political dimension, 212-213
  - indigenous, local, and traditional knowledge, 758, 765-766
  - information for, 171, 210-213
  - institutional context, 206-207
  - key concepts, 199-203
  - knowledge transfer, 198, 213
  - language and meaning, 204-205
  - learning, review, and reframing, 209-210
  - methods, tools, and processes, 207-210, 922
  - multi-attribute decision theory, 209
  - multi-metric, 957, 957
  - opportunity space for, 181-182, 182
  - psychology and, 204
  - in regional context, 1136, 1139, 1140
  - resilience and, 182, 198, 216-217
  - risk/risk management and, 198, 199-202, 201, 202, 215
  - scale issues, 1118
  - scenario-based projections, 213
  - scenarios and, 198, 208
  - social context, 203-206
  - stakeholder involvement in, 199, 209, 254, 837
  - sustainability and, 198, 216-218, 217
  - trade-offs, 208-209, 216, 217
  - transformational adaptation, 198, 217-218
  - uncertainties and, 56, 198, 207-208, 1386-1387
  - with uncertainty, 9, 956-958
  - wicked problems, 200-201, 208, 211
- Decision support**, 26, 87, 198, 202-203, 210-216
- climate information and services, 210-213
  - tools, 883, 902
  - in water resources, 255
- Deforestation\***, 283, 284, 1016
- in Amazon basin, 276, 284, 310, 1502, 1503, 1509-1510, 1514-1515, 1514, 1522-1523, 1535
  - avoided, 1540
  - carbon release by, 276
  - in Central and South America, 276, 284, 310, 1502, 1503, 1509-1510, 1514-1515, 1514, 1522-1523, 1535, 1540
  - REDD payments, 617, 630, 641, 797, 814, 965, 1111, 1119
  - reduction in, 276, 302, 1522-1523
- Delta Programme**, 391
- Delta Works**, 365
- Deltas**, 369, 380-381
- cities in, compound risk, 1058, 1059
  - tropical cyclones and, 147-148, 148
- Dengue fever**, 385, 723-725, 723, 731
- in Asia, 723, 723, 1348
  - in Caribbean, 724
  - climate-related factors and, 723
  - in Europe, 723
  - intervention to control, 724
  - near-term future, 725-726
  - in small islands, 1624
  - thermal tolerance of vectors, 736
  - vectors, 725, 736
- Deserts/desertification\***, 312
- in Africa, 1205, 1209, 1210, 1213, 1214, 1215, 1234
  - in Asia, 1330, 1339, 1344
  - in Europe, 1275
- Detection and attribution\***, 7, 42, 979-1037
- aggregate impacts, 1015, 1016
  - anthropogenic climate change, 982, 1502
  - assessing all climate change aspects, 1017
  - attribution, 986
  - attribution, challenges of, 1018
  - attribution of a single event, 1018
  - attribution to climate change, 7, 42
  - attribution to precipitation changes, 982
  - attribution to warming, 982
  - biological systems, 1015
  - cascading impacts, 983, 1012, 1013
  - challenges, 986, 1018
  - coastal systems, 991-993, 1007-1008
  - conclusions, 188-189, 1016-1017
  - confidence, 7, 184-185
  - coral bleaching, 992, 992
  - crop production, 996-997
  - cryosphere, 986-989, 987
  - definitions, 985-986
  - detection, 985-986
  - differences in land and ocean systems, 995
  - economic impacts, 997-998
  - extreme weather events, 998-1000, 999, 1014, 1014
  - food production systems, 996-997, 1017
  - freshwater resources, 986-989, 987
  - gaps, research needs, and emerging issues, 983, 1017
  - human and managed systems, 996-1003, 1009-1010, 1015, 1017
  - human interference with climate system, 3, 12, 37, 61-62
  - hydrological systems, 986-989, 987, 1013, 1015, 1016
  - impacts attributed to climate change, 30-32
  - importance of, 1017
  - indigenous people, 983, 1001, 1002, 1003, 1014
  - methodological concepts, 984-986, 985
  - natural systems, 986-996, 1014, 1015
  - new evidence, 982
  - ocean ecosystems, 993-996, 993, 994, 995, 1007-1008
  - phenology, 989
  - physical systems, 982, 984, 994, 1011, 1012
  - quantitative synthesis assessment, 986
  - Reasons for Concern, 983, 1013-1016
  - regional impacts, 30-32, 1001-1030, 1003-1010
  - of single weather events, 998-1000, 1018
  - terrestrial and inland water systems, 989-991
  - terrestrial ecosystems, 982, 983, 989-990, 1005-1006, 1017
  - traditional ecological knowledge and, 1007
  - water resources, 982, 986-989, 987
- Developed countries\***, 181
- adaptation experience, 51
  - poverty in, 796
- Developing countries**, 181
- adaptation experience, 51
  - adaptation in context of development path, 948
  - coastal area impacts/costs, 364
  - ocean systems and, 416
  - poverty in, 616, 623, 796, 797
  - rural poverty, 616, 623
  - sea-level rise, costs of, 364
- Development**
- adaptation and, 816, 882, 948, 954
  - adaptive capacity and, 1111
  - alternative development pathways, 1044, 1052, 1072-1073
  - ancillary or co-benefits, 948
  - Clean Development Mechanism (CDM), 797, 813-814, 848-849, 1111
  - climate-resilient development pathways, 818
  - of coastal areas, 364
  - country development terminology, 181
  - economic (See Economic development)
  - equity issues, 1351
  - greener, 180-181
  - Human Development Index (HDI), 720
  - inequalities and, 40
  - integrating with climate policies, 1111-1112
  - mitigation and, 1109, 1114-1115
  - pathways, 563-566, 1052, 1109
  - pathways of countries, 948
  - policy, climate change and, 1110
  - transformative, 538
  - See also Sustainable development
- Diarrheal diseases**, 689, 726, 727
- Diatoms**, 726
- Dinoflagellates**, 439, 726
- Disadvantaged populations\***, 796, 798, 799, 801-802, 806, 808
- Disaster risk management (DRM)\***, 27, 881-882
- adaptation and, 836, 871
  - community-based programs, 734
  - early warning systems, 734, 872, 877, 878, 883-885, 1145
  - insurance and, 686, 797
  - lessons from, 817
- Disaster risk reduction (DRR)\***, 91, 148, 390, 565-566, 565, 1296
- Hyogo Framework for Action, 14, 217

**Disasters\***

- education on, 733
- health care treatment during, 687-688
- preparedness programs, 714, 733
- SREX report, 680
- See also Extreme weather events; *specific disasters*

**Discount rates**, 959**Diseases**, 19-20, 713, 717-720

- age and gender and, 717-718
- air quality and, 727-730
- in Central and South America, 1503, 1532, 1532, 1535-1536, 1536, 1543, 1545
- cholera, 415, 455, 726, 1536
- climate change variability and, 717-720
- in coastal regions, 385
- current status, 717
- diarrheal, 726, 727
- early warning systems, 734
- floods and windstorms and, 722
- food production and, 500, 506-507
- mosquito-borne, 722-726, 723
- near-term future, 725, 727
- ocean systems and, 415, 431
- parasites, bacteria, and viruses, 726-727
- projected changes, 713, 725, 727
- rodent-borne diseases, 725, 1000
- in small islands, 1624-1625
- spatial distribution of, 713
- tick-borne, 722, 723, 725
- in urban areas, 556
- vector-borne, 713, 722-726, 723
- vulnerability to, 717-720
- water-borne, 713, 726-727
- zoonotic, 725, 726
- See also Human health; Infectious diseases; *specific diseases*

**Displacement**, 72

- forced, 736, 1175-1176
- health risks, 736
- numbers of people displaced, 768
- permanent, sea level rise and, 770, 770
- See also Migration, human

**Distribution of benefits (of mitigation)**, 1111**Distribution of impacts**, 12, 61, 241, 254, 1015, 1044, 1045, 1077

- ethical issues, 955-956

**Distribution of species**. See Species distribution**Disturbance regimes\***, 276, 277, 290

- abrupt changes and, 276
- fire, 290, 314, 317
- observed changes, 276, 290
- projected changes, 276
- See also Fires; Insect pests

**Downscaling\***, 211-212, 241, 1137-1138**Droughts\***, 232, 247-248

- agricultural, 232, 247-248, 247
- conclusions of AR4, 189
- detection and attribution, 44-46
- dryness, 81-84
- extreme events, 247-248, 248
- frequency and severity, 247-248, 247
- impacts, 248
- meteorological, 232, 247-248, 247
- migration and mobility outcomes, 769-770
- observed and projected changes, 1165-1170
- observed impacts, 7, 30-32, 44-46, 239-240, 620
- projected changes, 232

- rural areas, 616, 620-621
- urban areas, 538, 552, 555
- vulnerability/risk, 60, 63, 1070-1071
- wildfires and, 721
- See also *specific regions*

**Dryland ecosystems**, 308-312**Dryness**, 81-84**Durban, adaptation in**, 573, 592-593**Dust, airborne transcontinental**, 1616, 1633**Dynamic Global Vegetation Models (DGVMs)\***, 305**E****Early warning systems\***, 734, 872, 876, 878, 883-885, 1145, 1448, 1466, 1538

- adaptation experience, 52

**Earth system**, 985, 986, 1084

- Earth System Models (ESMs)\*, 282, 456
- large-scale interventions, 1114, 1121
- potential tipping points in, 1016

**East China Sea**, 1686-1687**Echinoderms**, 415, 438, 439, 465, 1633-1634**Ecological sustainability\***, 552**Economic costs of climate change**, 326-327, 326

- valuation of impacts, 617, 630-633, 632

**Economic development**, 662, 679, 688

- human health and, 713, 720

**Economic goals, trade-offs with environmental goals**, 1118-1119**Economic growth**, 663, 691-692, 997

- climate-resilient pathways and, 1114-1115
- conflict with environmental management, 1118
- human health and, 713
- Malthusian ideas, 1118

**Economic instruments**, 26, 87, 948-949, 963-966**Economic sectors and services**, 19-20, 50, 70-71, 659-708

- adaptation potential, 62-73
- aggregate impacts, 690, 690
- aquaculture, 676
- charges, 965-966
- climate change impacts on, 662, 690, 690, 997-998
- commercial sectors, 662, 671
- construction and housing, 677
- crop and animal production, 676
- detection and attribution, 997-998
- economic development, 662, 679, 688
- economic growth and productivity, 663, 691-692
- economic impact estimates, global, 663
- economic welfare, 662, 664
- electricity grids, 669, 669
- energy, 664-672, 693
- extreme weather events and, 50
- financial services, 680, 686-687
- fisheries, 676
- forestry and logging, 676
- health and health care, 663, 687-689, 693
- impacts on markets and development, 689-693
- insurance, 663, 680-687, 693
- key risks, 59-60, 59-62, 64-65
- macroeconomic impacts, 669-672, 670-671
- manufacturing, 677
- markets, 663, 688, 689-690, 690
- mining and quarrying, 676
- pipelines, 71, 668, 669, 675
- poverty traps, 692

## projected impacts, 70-71

## public-private partnerships, 686, 686

## recreation, 677-678

## research needs and priorities, 663, 693-694

## residential sectors, 662, 671, 676

## social cost of carbon, 690-691, 691

## summary, 692-693, 693

## supply and demand, 662, 664, 679

## tourism, 663, 677-679, 693

## transport, 662, 674-676, 693

## transport infrastructure, 662

## vulnerability, 664, 688

## water infrastructure, 662, 672, 693

## water services, 672-674, 693

## water supply, 662

**Economic welfare**, 662, 664**Economics**, 27, 945-977

## of adaptation (See Adaptation economics)

## analysis in face of uncertainty, 949

## economic analyses, desirable characteristics in, 949, 963

## economic instruments, 26, 87, 948-949, 963-966, 965

## global economic risk and impacts, 63, 71

## green fiscal policies, 90

## incentives, 949, 963-966

## macroeconomic analysis, 963

## multi-metric evaluations, 948, 957, 957

## PESETA project, 1059

## REDD payments, 965

See also Markets; Socioeconomic impacts; *specific systems and regions***Ecosystem-based adaptation\***, 101-103, 836, 846-847

## adaptation options, 845

## in coastal systems, 388

## costs of, 393

## cross-chapter box, 101-103

## in Durban, 573, 592-593

## payment for ecosystem services (PES), 641-642, 964, 1523, 1540-1541, 1541

## processes in, 102

## in rural areas, 641-642

## in urban areas, 539

**Ecosystem degradation**, 276**Ecosystem services\***, 319-321, 319, 659-708

## degradation of, 276

## economic costs related to, 326-327, 326

## emergent risks, 1042, 1053-1054, 1054

## ocean systems, 414, 452-453, 461-465

## payment for (PES), 641-642, 949, 964, 1523, 1540-1541, 1541

## projected changes, 274

## risks from large temperature increase, 63

## species composition and seasonal changes and, 274

## in urban areas, 538, 572-575

## valuation of, 956-957

## See also Economic sectors and services

**Ecosystems\***, 271-359

## abrupt changes in, 276

## adaptation and thresholds, 278-279, 321-328

## adaptation capacity, 277

## boundaries of, 278

## carbon dioxide effects on, 287

## climate change, effects of, 319

## degradation, 276

## detection and attribution, 42

## drivers of change, 274

- dynamic and inclusive view of, 278-290  
 economic costs of climate change, 326-327, 326  
 emerging issues, 328  
 GHG and climate change impacts on, 249  
 human influence on, 278  
 impacts/risks for major systems, 301-319, 302  
 key issues risks, 1058, 1071  
 management, 27, 453-454, 456  
 multiple stressors, 276, 283-290  
 observed impacts, 7, 30-32, 42-43, 982  
 paleoecological evidence, 279-282  
 projected impacts, 274-277  
 properties of, 278  
 protected areas, 324  
 regime shifts, 454  
 restoration of, 324  
 services (See ecosystem services)  
 thermal tolerance, 432  
 thresholds, 278-279  
 tipping points, 276, 278-279, 309-310, 316-317  
 uncertainties, 328  
 vulnerability/risk, 274-277, 290-321, 302, 1071  
 See also Biodiversity; Freshwater ecosystems;  
 Marine ecosystems; Terrestrial ecosystems
- Education**, 720, 731  
 access to, 19, 27, 70, 73, 154, 625  
 disaster education, 733  
 gender and, 39, 73, 105, 106  
 health education, 734  
 higher education, 1352  
 long-term resilience and, 148  
 options in, 27, 52  
 in rural areas, 70, 618, 625
- Egypt, Aswan High Dam**, 252
- El Niño Southern Oscillation (ENSO)\***, 1162  
 agriculture effects, 632  
 in Australasia, 632, 1377  
 conclusions of AR4, 191  
 droughts, correlation with, 239-240  
 economic impacts, 632  
 marine ecosystems and, 421  
 projected changes, 1162
- Elderly populations**  
 disproportionate impacts on, 47-48  
 health and, 717-718, 719, 720  
 in North America, 1451, 1452  
 vulnerability of, 47-48, 717-718, 809
- Electric power**, 566, 571, 671-672  
 brownouts and blackouts, 558  
 decarbonization of, 1353  
 outages, 737  
 prices of, 671-672
- Electricity grid**, 71, 669, 669
- Emergent risks\***, 59-60, 117, 1039-1099  
 alternative development pathways and, 1044, 1052, 1072-1073  
 assessing, 1052-1053  
 biofuel production, 1055-1056, 1056  
 biophysical impacts, 1043, 1072  
 carbon dioxide health effects, 1064-1065  
 climate change amplification of risks, 1057  
 compound risk, 1042, 1057-1059, 1058  
 conflict and insecurity, 1042, 1060-1061  
 criteria for identifying, 1052  
 crop production, prices, and food insecurity, 1059-1060  
 cross-chapter box, 113, 114-121  
 definition of, 1049  
 ecosystem services, 1042, 1053-1054, 1054  
 examples of, 1053-1059, 1054, 1070-1071  
 framework for, 1050-1053  
 geoengineering, 1043, 1065-1066  
 hazards, vulnerabilities and, 1070-1071  
 health effects, 1056-1057, 1064-1065  
 human migration, 1042, 1060  
 impacts of adaptation, 1060-1061  
 indirect, trans-boundary, and long-distance impacts, 1042-1043, 1059-1062, 1062  
 interactions of systems, 1042, 1046  
 management of water, land, and energy, 1042, 1054-1056, 1056  
 mitigation for risk management, 1080-1085, 1081  
 mitigation, unintended consequences of, 1042-1043, 1059, 1060, 1061-1062  
 multiple interacting systems and stresses, 1053-1059  
 new developments, 1049-1050  
 newly assessed risks, 1062-1066  
 ocean acidification, 1043, 1064, 1064, 1065, 1071  
 previous assessments, 1046-1047, 1053  
 Reasons for Concern, 1049, 1073-1080  
 species range shifts, 1042, 1061  
 summaries, 1042-1045  
 temperature rise beyond 4°C above preindustrial, 1062-1064
- Emissions reduction, co-benefits**, 714, 737-740
- Endemic species**. See Biodiversity
- Energy**, 664-672, 666  
 adaptation, 571  
 adaptation options, economic evaluation of, 962  
 efficiency, 91  
 electricity grid, 71, 669, 669  
 macroeconomic impacts, 669-672, 670-671  
 pipelines, 71, 668, 669  
 transport and transmission of, 668-669, 671  
 water-energy/feed/fiber nexus, 92-93, 163-166
- Energy access**, 817
- Energy supply**, 665-668, 666, 693  
 adaptation options, 665-667, 666, 737  
 biofuels (See Biofuel production)  
 biomass, 320  
 brownouts and blackouts, 558  
 climate impacts, 997-998  
 coal fuel, 668  
 detection and attribution, 997-998  
 electric power, 566, 571, 669, 669, 671-672  
 emergent risks, 1042, 1054-1056, 1056  
 extreme weather events and, 666, 671  
 hydropower, 252, 257-258, 666, 667  
 impacts on sources and technologies, 662  
 nuclear power, 662, 666, 667  
 in Ocean regions, 1660, 1705  
 offshore, 1660, 1705  
 oil and gas, 668  
 possible impacts, 666  
 renewable energy (See Renewable energy)  
 in rural areas, 617  
 solar power, 327, 666, 667-668  
 thermal power, 252, 662, 665-667, 666  
 tidal power, 1660  
 in urban areas, 558, 571  
 water for, 92-93, 163, 164, 252, 662  
 wind power, 327, 630, 666, 668
- Energy use/demand**, 664-665, 672, 693  
 for cooling and heating, 662, 693  
 demographics and, 662  
 economic impacts, 669-672, 670-671  
 governance of, 630  
 temperature and, 665, 672
- Engineered adaptation options**, 836, 845, 846  
 See also Geoengineering
- Engineering and built environment\***, 845, 846
- ENSO**. See El Niño Southern Oscillation (ENSO)
- Enterovirus infection**, 726
- Environmental adaptation needs**, 840-841
- Environmental goals, trade-offs with economic goals**, 1118-1119
- Environmental vulnerability**, 1068
- Equity**, 926, 1119  
 in adaptation choices and decisions, 948  
 in adaptation economics, 955-956  
 equitable development, 1351  
 equity weighting, 926  
 See also Inequality
- Erosion**  
 beaches, 1524, 1525, 1620, 1624  
 in coastal systems, 17, 44-46, 69, 364, 376, 381, 386, 991  
 observed impacts, 988-989  
 soil, 233, 237-239, 246
- Estuaries**, 379-380
- Ethanol/bioethanol**, 1110, 1533, 1534
- Ethics**, 180, 925-927, 926  
 adaptation and, 903, 925-927, 926  
 in decision making, 198, 205-206  
 and distributional issues in adaptation economics, 955-956  
 equity concept, 926  
 equity weighting, 926  
 moral hazard, 964
- Europe**, 74, 1267-1326  
 adaptation, 8, 22, 51, 53, 1270, 1271, 1273, 1295-1298, 1295, 1297, 1302  
 adaptation costs, 1271, 1273, 1297-1298, 1297  
 adaptation limits, 922, 1270, 1298, 1298  
 adaptation, unintended consequences, 1273, 1298-1300  
 adaptive capacity, 1273  
 agriculture, 1271, 1284-1286, 1285, 1286, 1299, 1302-1303, 1304  
 air quality, 1272, 1293-1294  
 alpine region, 1274, 1274, 1301  
 Atlantic region, 1274, 1274, 1301  
 avalanches, 1281  
 banking, 1283  
 biodiversity, 1289, 1294-1295, 1297, 1299-1300, 1300, 1304  
 bioenergy production, 1288-1290, 1299, 1304  
 biological conservation, 1299-1300  
 built environment, 1281, 1303  
 cereal, 1271, 1284, 1300  
 coastal regions, 1270, 1279-1280, 1294-1295, 1305  
 coastal zone management, 1296  
 co-benefits of adaptation and mitigation, 1298-1300  
 conclusions from previous assessments, 1274-1275  
 continental region, 1274, 1274, 1301  
 crop yields, 510, 1270, 1271, 1302-1303  
 cultural heritage, 1272, 1292-1293, 1301, 1303  
 current and future trends, 1275-1279

- detection and attribution, 44, 1003-1009, 1006, 1303, 1304
- disaster risk reduction, 1296
- diseases and vectors, 723, 1272, 1288, 1303, 1305
- droughts and dry spells, 247, 625, 1278, 1279, 1280
- economy/economic impacts, 1270, 1271, 1297-1298, 1297
- ecosystem impacts, 1294-1295
- ecosystem services, 1270, 1288-1289
- energy, 1271, 1282-1283, 1282, 1301, 1303
- environmental quality, 1293-1295, 1299-1300, 1301, 1304
- EuroHEAT project, 734
- European Climate Change Oscillation (ECO), 1159-1161
- extreme events, 42, 1270, 1276-1279, 1280, 1301-1302
- fires, 999, 1287-1288, 1287
- fisheries and aquaculture, 1290, 1304
- flood damages, 633, 673, 1270-1272, 1280, 1304
- flood defenses, 53, 1146, 1157
- flooding, 239, 1270-1271, 1279-1281
- food production, 1284-1286, 1285, 1305
- forestry, 1287-1288, 1299
- forests, 311, 1270, 1272, 1287-1288
- glaciers, 243, 988, 1304
- grasslands, 318
- heat waves, 720, 721, 729, 999, 1278, 1280, 1290-1291
- human health, 1270, 1272, 1293, 1299
- impacts by sector, 1270-1272, 1279-1295, 1301
- impacts by sub-region, 1301
- infrastructure, 1270, 1291, 1302
- insurance, 1283
- integrated water resource management, 1296
- inter-regional implications, 1303-1304
- intra-regional disparity, 1270, 1303
- irrigation, 1271, 1275, 1284, 1286
- key risks, 22, 77, 118
- knowledge gaps and research needs, 1304-1305
- lakes, 313
- land degradation, 1293
- land use planning, 1296-1297
- livestock, 511, 1286
- manufacturing and industry, 1283
- marine ecosystems and species, 1272
- mitigation policy, 1298-1299
- non-climate trends, 1275
- Northern region, 1274, 1274, 1301
- observed changes, 81-82, 1270, 1275-1277, 1303, 1304
- observed impacts, 30, 44, 1003-1009, 1006
- ozone, 1272
- phenology, 1270
- plant pests, 1272
- policy frameworks, 1274
- precipitation, 81-82, 1276, 1277, 1279
- projected changes, 74, 81-82, 1270
- projected climate change, 1276-1279, 1277-1278
- protected areas, 324
- range shifts, 1272
- risk management, 1296
- rural development, 1297, 1302
- sea level rise, 1270-1271, 1272, 1279
- settlements, 1279-1281, 1301
- shrublands and grasslands, 311
- social welfare, 1290-1293, 1299, 1301
- soil quality, 1293
- Southern region, 1274, 1274, 1301
- sub-regions, 1274, 1274, 1301
- synthesis of key findings, 1300-1306
- temperature, 81-82, 1271, 1275-1276, 1278, 1280
- terrestrial and freshwater ecosystems, 1294, 1303
- tourism, 253, 384-385, 679, 1271, 1283
- transport, 1271, 1281-1282, 1301
- vulnerabilities, 1300-1303, 1301
- water quality, 1294
- water resources, 250, 250, 1286, 1296, 1302
- windstorms/wind speed, 1279, 1281
- wine production, 1271-1272, 1292
- Eutrophication\***, 257, 313, 415, 420
- in coastal areas, 364, 373, 380, 465
- Evapotranspiration**, 157-161, 257
- CO<sub>2</sub> effects on, 307
- drivers of change, 240-241
- feedbacks, 274
- observed impacts, 236, 294
- projected changes, 241-243
- Evolutionary adaptation\***, 322-323, 415, 426
- Ex situ conservation**, 326
- Exposure\***, 3, 26, 1043, 1051, 1074
- adaptation examples, 1145-1148
- climate change and, 1042, 1074
- in coastal systems, 364, 372-373, 381
- definition of, 39, 1049
- differential, 1066-1067
- interactions of, 1046
- observed impacts, 40-51
- trends in, 1067
- in urban areas, 556-560
- Externalities\***, 1119
- Extinction**
- climate change and, 295
- extinction debt, 301
- global, 299-300
- keystone species, 295
- in marine ecosystems, 451
- mass, 427
- observed impacts, 295, 299-300, 982
- in ocean systems, 451, 456
- projected changes, 14-15, 275, 300-301
- regional, 451
- risk, 14-15, 63, 64, 67, 275
- Extratropical cyclones\***, 368, 1333-1334, 1447, 1454, 1459
- effects on small islands, 1632
- Extreme climate events**. See Extreme weather events
- Extreme sea level**. See Sea level change; Storm surge
- Extreme weather events\***
- in Australasia, 721, 1374, 1380-1381
- climate extremes, adaptation to, 91
- conclusions of AR4, 189-190
- costs of, 633, 805, 982, 998, 1016
- detection and attribution, 620-621, 998-1000, 1014, 1014
- detection and attribution of single events, 998-1000, 1018
- in Europe, 1276-1279, 1280
- floods, 236, 247-248, 248
- heat waves and temperature extremes, 189, 720-721
- human health and, 663
- hydrological events, 236
- importance of understanding, 84
- insurance and, 663
- in North America, 1443-1445, 1447, 1450, 1470, 1472, 1478
- observed impacts, 6, 40-42, 998-1000, 999, 1014, 1014
- in ocean systems, 453
- poverty and, 802
- precipitation, 1162-1163, 1163-1170
- projected changes, 1162-1171, 1163-1170
- psychological effects, 805
- Reasons for Concern, 12, 61, 1014, 1014, 1044, 1076
- recent disasters, 999
- regional projections, 1162-1171, 1163-1170
- risks associated with, 1014, 1014, 1045, 1058, 1069
- in rural areas, 616, 620-621, 623, 633
- SREX report, 187-188, 247, 620, 680, 1047-1049, 1163-1164
- temperature, 60, 1070-1071, 1162, 1163-1170
- in urban areas, 548, 559, 568
- vulnerability/risk, 59, 1070
- See also Droughts; Floods; Heat waves; Hurricanes; and specific systems and regions
- Extremes, climate, adaptation to, 91**
- F**
- FACE (Free Air CO<sub>2</sub> Enrichment) studies**, 287, 288, 495, 499
- Family planning services**, 740-741, 742
- Farming**. See Agriculture; Crop yields
- Fifth Assessment Report**, 175, 176-182, 176-177
- context for, 4, 38-39
- core concepts, 3, 3-4, 85
- literature and authorship, 38, 171
- Financial flows**, 1171-1172
- Financial markets**. See Markets
- Financial services**, 680, 686-687
- adaptation constraints, 914-915
- adaptation finance, 392, 843-844, 845, 848-849, 878-881
- adaptation finance, distribution of responsibilities, 952, 952
- adaptation finance, eligibility for, 952, 952
- climate change impacts on, 680, 687
- risk-based capital, 684
- risk financing, 686, 949
- weather risks, products responding to, 684-686, 685
- See also Insurance
- Fire disturbance regime**, 290, 314, 317
- Fires**
- in Australasia, 721, 1374, 1375, 1381, 1400, 1408, 1413
- carbon emission from, 276
- in Europe, 1287-1288, 1287
- in North America, 1460-1461, 1477
- observed changes, 7, 276, 304
- projected changes, 303, 304
- smoke-related health effects, 721, 729
- wildfire management, 276
- See also Forest fires

**First Assessment Report (FAR), 174, 175****Fish**

biomass reduction, 416  
 body size, 414, 458, 459  
 carbon dioxide effects on, 441  
 distribution and range shifts, 295, 384, 414, 451  
 extinctions, 300  
 habitat fragmentation, 327  
 ocean acidification and, 415, 438, 676  
 projected impacts, 415-416, 507-508, 507  
 thermal windows for, 427-428, 427  
 tuna, 507, 1629  
 upwelling and, 149  
 water temperature and, 295, 429-430

**Fisheries**, 68-69, 69, 452-453, 676, 1681  
 adaptation, 489, 516-517, 519-520, 642  
 artisanal, 637, 644  
 catch potential, changes in, 124, 414-415, 459, 461  
 coastal area impacts, 380, 384  
 detection and attribution, 997  
 exploitation and overfishing, 69, 452, 456  
 food security and, 414-415  
 high-latitude, 414, 508  
 management, 456, 516  
 marine, 16, 18, 68-69, 69, 1659-1660, 1663, 1699, 1701-1704, 1707-1708, 1708  
 marine capture, 1701  
 observed changes, 384, 493, 997  
 pelagic, 150, 384, 435, 1016, 1702, 1708  
 in polar regions, 1584, 1590-1591  
 production by, 150, 416, 489, 493  
 projected impacts, 16, 68-69, 69, 384, 452-453, 457-459, 458, 465, 507-508, 507  
 in rural areas, 627-628, 632-633, 637, 642, 644  
 shellfish, 64, 1701  
 in small islands, 1616, 1621, 1629  
 small-scale, 1702-1703  
 spatial shifts in species, 414-415, 493, 994  
 tuna, 507, 1629  
 UN Straddling Fish Stocks Agreement (UNSFSA), 1713  
 valuation of, 452, 632-633  
 vulnerability/risk, 68-69, 416, 452, 500-501, 516, 1699

**Floods\***

adaptation, 52, 962, 1146  
 conclusions of AR4, 189  
 costs, 633  
 detection and attribution, 44-46  
 economic impacts, 673  
 extreme events, 234, 247-248, 248  
 flash floods, 805  
 flood defenses, 1146, 1157, 1181, 1297  
 frequency and severity, 66, 232, 239, 247-248, 247, 248, 722  
 hazards of, 232, 240, 242, 247, 247, 1070  
 health impacts, 721-722  
 impacts, 59, 248  
 inland, 59  
 insurance, 885  
 mental health impacts, 722  
 migration and mobility outcomes, 769-770  
 observed changes, 7, 30-32, 44-46, 232  
 projected changes, 247  
 projected frequency of 100-year floods, 248  
 projected impacts and interactions, 232, 247, 248

risk reduction, 1145  
 river floods, 721  
 in urban areas, 319, 538, 555-556, 557-558, 804, 962  
 vulnerability/risk, 1070  
*See also specific regions*

**Flows**

flow-on effects, 1408-1410  
 river flow regimes, 143-146  
 water flows, vegetation and, 157-161  
*See also Streamflow*

**Food access**, 488, 502-503, 503, 763**Food aid**, 734**Food-borne infections**, 726-727**Food crops**, 616, 623-625

*See also Agriculture; Crop yields*

**Food/feed/fiber, energy and water for**, 92-93, 163-166**Food prices**, 491, 494, 495, 568

biofuel production and, 815  
 emergent risks, 1059-1060  
 food-price shocks, 763  
 health impacts, 730  
 increases in, 6-8, 796, 797, 802, 812  
 links to climate, 763  
 poverty and, 796, 797, 802  
 projected impacts, 512-513, 623, 625

**Food production systems**, 17-18, 30-32, 49-50, 485-533

adaptation, 489, 513-520, 922  
 adaptation barriers and limits, 518  
 adaptation case studies, 518-519  
 adaptation, facilitating, 518  
 adaptation, key findings and confidence levels, 519-520  
 aquaculture, 488, 500-501, 508, 516  
 assessment methods, 494-497  
 carbon dioxide effects on, 251, 488, 493, 494, 495, 499, 506  
 in Central and South America, 1503, 1527-1531, 1528-1529, 1544, 1545  
 coral reef ecosystems, 493  
 crop models, 496  
 crop production, 488, 491-493, 505-507, 505, 519, 982  
 crop yields (*See Crop yields*)  
 detection and attribution, 44-46, 491-494, 996-997, 1017  
 diversification of, 515  
 drivers, 490  
 extreme events and, 503, 507  
 fisheries, 452-453, 489, 493, 500-501, 507-508, 507, 516-517, 519-520  
 food processing, 489  
 food quality, 501-502  
 food security and, 494  
 food systems, 490, 490  
 high-latitude regions, 488, 508  
 human health and, 501-502  
 impact assessment, 494-505  
 indigenous knowledge, 517, 520  
 key risks, 114, 1058, 1069-1070  
 land use and, 504-505, 504, 507  
 limits to food production, 736  
 livestock, 494, 502, 508-512, 517, 519-520  
 observed impacts, 7, 30-32, 44-46, 49-50, 488-489, 491-494, 982, 996-997, 1017  
 ocean acidification and, 507

oceans and marine ecosystems, 452-453, 456  
 ozone effects on, 488, 493, 499  
 phenology, 499  
 precipitation and, 488, 489  
 projected impacts, 17-18, 18, 488-489, 505-513, 509-512  
 sensitivity to weather and climate, 497-502, 504-505, 504  
 smallholders, 503  
 summary from AR4, 491  
 temperature and, 488, 489, 492-493, 492, 516  
 trade-offs, 489  
 tropical bearing crops, 625, 626-627, 641, 1528  
 vulnerabilities and risks, 494-505  
 water-energy/feed/fiber nexus, 92-93, 163-166  
 water use, 251-252, 516-517  
 weeds, pests, and disease, 488, 500, 506-507  
*See also Agriculture; Crop yields*

**Food security\***, 18, 49-50, 69-70, 485-533

adaptation and, 514-516, 514, 519  
 adaptation case studies, 518-519  
 in Asia, 1343-1346, 1344, 1354  
 current state of, 490-491  
 drivers and responses, 490  
 droughts and, 494, 515  
 emergent risks, 1059-1060  
 extreme events and, 503  
 fisheries and, 414-415, 493, 507-508, 507  
 food access, 488, 502-503, 503  
 food availability, 763  
 food deficits, 629  
 food demand, 489  
 food insecurity, 490-491  
 food prices and, 491, 494, 495, 512-513, 568, 623, 625, 763  
 food production and, 494  
 food quality and, 501-502  
 health vulnerabilities, 713  
 impacts on, 488-489  
 indigenous knowledge, 517, 520  
 key risks, 114, 519, 1058, 1069-1070  
 links to climate, 763  
 nutrition/nutrients, 488, 490, 501-502, 507  
 poverty and, 491, 797  
 price stability, 488  
 price volatility, 491, 495, 513  
 projected impacts, 18, 69-70, 488-489, 512-513  
 research and data gaps, 520  
 in rural areas, 616, 623-625, 628-630  
 sensitivity to weather and climate, 502-504  
 stability, 503  
 temperature increase and, 63, 489, 736  
 undernutrition and, 713  
 in urban areas, 539  
 utilization, 503-504  
 vulnerability/risks, 60  
 water resources and, 232

**Food webs**, 448, 449  
 in coastal areas, 380  
 marine, 424, 448, 449, 459-460  
 ocean acidification and, 131  
 phytoplankton and, 424, 448, 451  
 tundra, 1016

**Foraminifera**, 415, 440

**Forest fires**, 1016  
 air pollutants from, 721, 729  
 in Europe, 1287-1288, 1287  
 health effects of, 721, 729

- in North America, 1460-1461  
 observed changes, 304  
 projected changes, 304  
 in Russia (2010), 305, 729, 999  
*See also* Fires
- Forestry**, 320, 325, 676  
 adaptation, 962  
 in Asia, 1340  
 in Australasia, 1393-1396  
 in Europe, 1287-1288, 1299  
 FACE studies, 287, 288, 495, 499  
 management and adaptation, 640-642  
 in North America, 1460, 1471, 1472, 1477
- Forests**, 301-307  
 afforestation, 233, 257, 284, 317, 321  
 Amazon, 276, 284, 310, 982, 990-991  
 biomass, 989-990  
 boreal, 303-305  
 as carbon sink/source, 301, 305, 320  
 carbon stocks, 293-294  
 conversion to non-forest, 283  
 deforestation (*See* Deforestation)  
 dieback, 15, 66, 276, 306-307, 1016  
 insect infestations/damage, 289-290, 1016, 1443, 1447, 1458, 1459  
 management, 640-642  
 mangrove, 992, 1145, 1155  
 in North America, 1459, 1460-1461  
 pest species, 289-290, 1459  
 plantation forestry, 317-318  
 planting of fast-growing trees, 277  
 rainforests, 276  
 range/biome shifts, 307  
 REDD payments, 617, 630, 641, 797, 814, 965, 1111, 1119  
 reforestation, 277, 317, 321, 1062  
 temperate, 305-307  
 tree mortality, 15, 110, 276, 306-307, 308  
 tropical, 158, 284, 307-308, 990-991  
*See also* Amazon region; Deforestation; Forest fires; Forestry
- Fourth Assessment Report (AR4)**, 175, 176, 182-184
- Fracking (hydraulic fracturing)**, water use for, 258
- France, climate extremes and heat waves**, 720, 721, 999, 1280
- Freshwater ecosystems**, 14-16, 143-146, 249, 253, 271-359  
 adaptation, 277, 321-328  
 biodiversity, 274  
 carbon sequestration, 275  
 carbon stocks, 294  
 climate change and, 232  
 cross-chapter box, 143-146  
 land use and, 274  
 management actions, 277, 324-325, 325  
 nitrogen deposition, 286  
 observed impacts, 44-46, 44-48  
 river flow regimes, 143-146  
 species distribution, 274, 991  
 species invasions, 990  
 stressors and threats, 312  
 vulnerability and risks, 274-277, 290-321, 302
- Freshwater-related risks**, 66, 232-233, 248-253, 249
- Freshwater resources**, 229-269  
 adaptation and risk management, 14, 234, 253-258  
 adaptation barriers, 233, 254
- adaptation, mitigation, and sustainable development, 233  
 adaptation opportunities, constraints, and limits, 922  
 climate change and, 232, 234, 251, 257, 274  
 climate change mitigation and, 257-258  
 climatic drivers, 240, 256  
 costs and socioeconomic aspects, 233  
 detection and attribution of impacts, 234-236, 235, 986-989, 987  
 droughts, 232, 239-240, 247-248, 247  
 ecosystems, 249  
 energy production, 252  
 erosion and sediment load, 237-239, 246-247  
 evapotranspiration, 236, 240, 241-243  
 extreme hydrological events, 236, 239-240  
 flood frequency and severity, 232, 239, 247-248, 247, 248  
 flood hazards, 232, 240, 242, 247, 247  
 framework and linkages, 234  
 glaciers, 233, 242, 243  
 greenhouse gas concentrations and, 232  
 groundwater, 14, 237, 238, 243-246, 250, 250  
 hydrological changes, 234-240  
 hydropower generation, 233, 252, 257-258  
 impact assessment methods, 241  
 impacts, 234, 241-248, 982, 986-989, 987  
 impacts of adaptation in other sectors, 257  
 Integrated Water Resources Management (IWRM), 254  
 key risks, 66, 232-233, 256  
 land use and, 240-241  
 linkages with other sectors and services, 257-258  
 municipal services, 252-253  
 negative impacts on, 234  
 nonclimatic drivers, 240-241  
 observed changes, 44, 234-240  
 permafrost, 236, 243  
 precipitation, 236  
 projected changes, 14, 234, 241-248  
 projected extremes, 247-248, 248  
 projected impacts, vulnerabilities, and risks, 248-253  
 renewable water, decreases in, 232  
 research and data gaps, 258-259  
 risks, 232-233  
 runoff, 237, 243, 245  
 sea-level rise and, 253  
 soil erosion, 233, 237-239, 246  
 soil moisture, 232, 236, 239, 241-243, 247, 249  
 streamflow, 236-237, 243, 244  
 surface water, 232, 233, 250-251  
 vulnerability/risk, 248-253, 250  
 water availability, 248-251, 251  
 water management, 215, 233, 253, 254-256, 255, 258  
 water quality, 237, 238, 246, 251, 252  
 water temperature, 232, 234, 235, 237, 238, 252, 253, 274, 295  
 water uses, 251-253  
*See also specific regions*
- Frogs**. *See* Amphibians
- Funding gap**, 28, 87, 844, 953
- G**
- GDP**. *See* Gross Domestic Product
- Gender**, 105-107
- access to land, 635  
 adaptation options and, 617  
 caste system and, 799, 807, 808  
 climate change impacts and, 796, 807-808  
 cross-chapter box, 105-107  
 education and, 39, 73, 105, 106  
 emotional and psychological distress, 808  
 entrepreneurship and financing, 106, 635  
 feminization of responsibilities, 808  
 gender roles, 105-106, 799, 1002  
 gendered climate experiences, 807  
 health and, 718  
 inequalities, 19, 47-48, 796, 806-807  
 livelihood impacts, 807  
 male out-migration, 808  
 mortality, 808  
 occupational hazards, 808  
 rural areas, issues in, 617, 635  
 vulnerability and, 105-106, 635, 644, 718
- Gene banks**, 326
- Genetic responses to climate change**, 322-323, 426, 1709
- Geoengineering\***, 91, 1114  
 Carbon Dioxide Removal (CDR), 454  
 conflict over, 776-777  
 crops with reflective leaves, 321  
 examples of, 1114  
 large-scale interventions, 1114  
 in oceans, 416, 454, 455  
 risks of, 454, 455, 1065-1066  
 solar radiation management (SRM), 416, 454, 455, 776, 1065-1066  
 sustainable development and, 1114  
 techniques, 455
- Geopolitical issues**, 775-777
- Germany**, insurance losses, 682
- Giorgi-Francisco regimes**, 1160
- Glacial lakes**, 242
- Glacial rivers**, 239
- Glacier lake outburst floods (GLOFs)**, 988, 1000, 1002
- Glaciers**, 233  
 aggregate impacts, 1016  
 in Asia, 242, 243, 1337, 1356, 1357  
 average rate of ice loss (1993-2009), 1136  
 in Central and South America, 623, 1518-1520, 1519, 1521, 1522, 1543, 1543  
 committed changes, 233  
 conclusions of AR4, 190  
 in Europe, 243, 988, 1304  
 Himalayan glaciers, 242  
 meltwater from, 233, 239  
 observed changes, 7, 236, 982, 987, 987, 1075, 1136  
 projected changes, 233, 242, 243, 253, 312  
 runoff from, 145, 987, 987, 1075-1076  
 vulnerability/risk, 1075-1076
- Global Environmental Facility (GEF)**, 874
- Global sea level**. *See* Sea level; Sea level change
- Global temperatures**. *See* Temperature
- Global warming**. *See* Climate change; Temperature; Temperature impacts; Temperature projections
- Globalization**, 616, 1303
- Governance/government**, 26, 207  
 adaptation and, 842-843, 845, 849, 1475-1476  
 adaptation planning and implementation, 25, 85-87, 388-390, 874-875, 886-889  
 government failures, 956  
 insurance and, 686, 686



- leadership, 540, 589-590  
 local, 566, 577-578, 836, 842-843, 876  
 national adaptation responses, 871  
 national governments, 25, 27, 85, 842, 1475  
 policy on environmental migrants, 771, 771  
 rural areas, 617  
 security and national security challenges, 758  
 stakeholder participation, 540, 1473-1475  
 state integrity and geopolitical rivalry, 72-73, 775-777  
 subnational level adaptation, 85, 1475-1476  
 urban governance, 538-540, 566, 575-578, 578
- Grain crops**, 488, 491-493, 492  
 projected impacts, 488-489  
 sensitivity to climate change, 497-499, 498  
 temperature and, 488, 498  
*See also* Agriculture; Crop yields; *specific regions*
- Grapes**, 499, 506, 625
- Grasslands**, 311, 311-312, 637
- Great Barrier Reef**, 431, 1393
- Green and white roofs**, 90, 574-575
- Green economy**, 567
- Green fiscal policies**, 90
- Green infrastructure**, 90, 560, 572-575, 847, 884
- Greener development**, 180-181
- Greenhouse gases (GHGs)\***, 50, 171, 188-189, 249  
 feedbacks, 274  
 mitigation, 903, 1045  
 release from permafrost, 67  
 vulnerability/risk and, 66, 852  
 water resources and, 15, 66  
*See also* Carbon dioxide
- Greenland ice sheet**, 63
- Gross Domestic Product (GDP)**, 811-812  
 impacts computed as a percent of, 364, 631
- Groundwater**, 66, 243-246  
 attribution of changes, 237  
 coastal groundwater, 246, 364, 379  
 observed changes, 237, 238  
 pollutants in, 252  
 projected changes, 14, 243-246, 250, 625  
 salinization, 633, 991  
 vulnerabilities, 250-251, 250
- Groundwater recharge\***, 158, 244-246, 250
- Growing season**. *See* Phenology
- Gulf of Mexico**, 1678
- H**
- Habitat**  
 destruction, 375, 414, 1707  
 fragmentation, 275, 327-328  
*See also* Biodiversity; Ecosystems
- Hailstorms**, 683
- Hantavirus**, 725, 1224, 1536
- Hard and soft limits**, 89, 903, 907, 919-921
- Harmful algal blooms (HABs)**, 439-440, 454-455, 465, 726, 1582, 1709, 1712
- Hazards**, 37, 113, 114-121, 1042, 1070-1071  
 definition of, 39  
 novel, 59
- Health**. *See* Human health
- Health care**, 663, 687-689, 693, 733  
 costs, 687-689, 737
- Heat islands**. *See* Urban heat islands
- Heat-related deaths**, 42, 60, 720-721, 736, 983, 1058, 1069, 1374  
 in Australasia, 1375, 1402-1403, 1411  
 in Europe, 1280, 1290-1291, 1307  
 in North America, 1470, 1477
- Heat strain/exhaustion**, 731, 733
- Heat stress**, 109-111  
 effect on livestock, 517, 627  
 gender and, 106  
 in urban areas, 538, 556  
*See also* Thermal stress
- Heat stroke**, 731
- Heat waves\***, 109-111, 558, 720-721  
 in Australasia, 42, 1374, 1375, 1380, 1400, 1401, 1402, 1405, 1407, 1411, 1413  
 brownouts and blackouts, 558  
 cross-chapter box, 109-111  
 disproportionate impacts, 109  
 early warning systems, 883-885, 1145  
 in Europe, 720, 721, 729, 999, 1278, 1280, 1290-1291  
 frequency and intensity of, 721  
 mortality from, 42, 60, 110, 720-721, 736, 983, 1058, 1069, 1374  
 in North America, 721, 1444, 1470, 1477  
 observed and projected changes, 1165-1170  
 in Russia, 503, 729, 999  
 violence and, 109
- Hemorrhagic fever with renal syndrome (HFRS)**, 725
- Herbicides**, 500
- Heritage benefits**, 453
- Heritage sites**, 560, 1272, 1292-1293, 1301, 1303
- High-altitude ecosystems**, 17, 274, 312, 995  
 responses to climate change, 317  
 species distribution, 274  
 species range shifts toward, 274, 278-279, 279  
 tourism increases, 678  
*See also* Mountain regions
- High-latitude ecosystems**, 124, 274, 312  
 deforestation, 283  
 fisheries, 414, 508  
 food production, 488  
 impacts/risks, 301, 1010  
 primary productivity in, 293, 415  
 tourism increases, 678  
 water resources, 251
- Honeybees**, 320-321
- Hotspots\***, 20, 1137, 1177-1178, 1463
- Housing**, 538, 539, 559-560, 568-570, 676
- Human-assisted adaptation\***, 324-326, 325, 328
- Human capital**, 761, 762, 774
- Human Development Index (HDI)**, 720
- Human health**, 19-20, 50, 71, 709-754  
 adaptation, 712, 733-737, 735, 742, 922  
 adaptation options, economic evaluation of, 962  
 adaptation policies, 733-734  
 adaptation under high levels of warming, 735-737  
 aeroallergens, 729, 1043  
 air pollution, 713, 716, 727-730  
 air quality, 721, 727-730  
 carbon dioxide effects on, 1043, 1064-1065  
 child health services, 714  
 childhood mortality, 688  
 climate-altering pollutants (CAPs), 713, 714, 715, 716, 728, 728  
 climate change and, 713, 716-717, 716, 735, 741  
 climate change benefits for, 742  
 climate change variability and, 717-720  
 co-benefits, 714  
 in coastal areas, 385-386  
 co-benefits, 714, 737-741, 737, 738, 753  
 costs, 687-689, 737  
 dengue fever, 723-725  
 detection and attribution, 1000  
 direct impacts of climate and weather, 720-722, 741  
 disaster preparedness, 714  
 disease distributions, 713  
 diseases, 713, 722-730  
 diseases, vulnerability to, 717-720  
 drought and, 721  
 early warning systems, 734, 1466, 1538  
 economic development and, 713, 720  
 elderly people, 717-718, 719, 720  
 emergent risks, 1042, 1056-1057, 1064-1065  
 extreme events and, 663, 721  
 fires and smoke, 721, 729  
 floods and, 721-722  
 food-borne infections, 726-727  
 food production and, 713  
 food quality and, 501-502  
 food security, 736  
 health adaptation policies, 733-734  
 health care costs, 687-689, 737  
 health care services, 663, 687-689, 693, 733  
 heat- and cold-related impacts, 713, 720-721, 731, 983  
 heat-related deaths, 110, 713, 720-721, 736, 983  
 heat tolerance, limits to, 736  
 heat waves and, 110, 720-721  
 impacts, direct, 50, 720-722, 741  
 impacts, ecosystem-mediated, 722-730  
 impacts, human system-mediated, 730-733  
 impacts, mechanisms of, 713  
 infectious diseases, 663, 722-726  
 injuries and drowning, 713, 717, 721, 731  
 key risks, 116  
 knowledge gaps, 714  
 malaria, 722-723  
 malnutrition, 688, 730-731, 1530, 1537  
 meat consumption, 714, 742  
 mental health, 722, 732, 1404  
 nutrition, 730-731, 730  
 observed impacts, 1000  
 occupational health, 731-732  
 ocean systems and, 415, 431-432, 454-455  
 ozone and, 716  
 physical infrastructure and, 718, 736-737  
 population growth and, 718  
 populations most affected, 742  
 present state of global health, 715-716, 720  
 projected changes, 71, 713  
 projections under RCP scenarios, 713  
 protecting, 733-734, 735  
 public financing of, 688  
 public health, 714, 718, 733, 738  
 reproductive health services, 740-741, 742  
 research gaps, 714  
 rodent-borne diseases, 725, 1000  
 in rural areas, 623  
 socioeconomic status and, 718  
 storms and, 721-722  
 temperature and precipitation and, 713, 1000  
 thermal thresholds, 713  
 thermoregulation, 713, 720-721  
 tick-borne diseases, 722, 723, 725, 1000

- ultraviolet radiation and, 722  
 uncertainties and knowledge gaps, 714, 741  
 in urban areas, 556, 560  
 vaccinations, 21, 714, 733  
 vector-borne diseases, 722-726  
 violence and conflict, 732-733  
 vulnerability mapping, 733-734  
 vulnerability projections, 718-720, 719  
 vulnerability reduction, 714  
 vulnerability/risk, 60, 72, 717-720, 1042, 1058, 1069  
 water-borne infections, 726-727  
 weather and, 713, 715  
 weather shifts and, 713  
 work capacity, temperature and, 19, 71, 713, 731, 732  
*See also Diseases; specific diseases*
- Human migration.** *See* Migration, human
- Human-modified land systems,** 317-319
- Human population**  
 in Asia, 1332, 1347  
 in coastal areas, 364, 372-373, 381, 386  
 growth, health and, 718, 740  
 in North America, 1450-1452, 1451  
 in rural areas, 616, 618, 618, 622  
 slowing growth through fertility, 740-741  
 in urban areas, 50, 538, 541-547, 544, 553, 554, 622  
 water availability and, 250
- Human rights,** 759
- Human security\*,** 20, 50, 71-73, 73, 755-792  
 adaptation, 762, 766, 778-779  
 adaptation opportunities, constraints, and limits, 922  
 agriculture, 761, 762, 763, 766, 768-769  
 armed conflict, 758, 771-775, 772, 773  
 basic needs, 761  
 climate change and, 759, 760, 1001-1002  
 culture and, 71-72, 758, 762-766, 764  
 definition and scope, 759-761  
 economic dimensions, 761-762, 761  
 food prices and insecurity, 763  
 geopolitical issues, 775-777  
 human capital, 761, 762, 774  
 human rights, 759  
 indigenous, local, and traditional knowledge, 758, 765-766, 766  
 key risks, 39, 778  
 livelihood security, 758, 761-762, 761  
 migration, 758, 766-771, 769-770, 777  
 mobility, 758, 766-770, 769-770  
 multiple factors in, 758  
 national security policies, 758  
 observed changes, 50, 1001-1002  
 projected changes, 71-72  
 property, 761, 762, 773-774, 779  
 scales of, 73  
 state integrity, 72-73, 775-777  
 states, challenges to, 758, 760  
 synthesis, 777-779, 777, 778  
 threats to, 758, 762  
 vulnerabilities, 758, 761, 778  
 vulnerable populations, 758, 761  
 water scarcity, 761-762, 761
- Human settlements**  
 in coastal areas, 364, 381-383, 382, 993  
 informal settlements\*, 538, 583, 805-806  
*See also* Rural areas; Urban areas
- Human systems\***  
 in coastal areas, 381-386  
 detection and attribution, 42, 982, 996-1003, 1009-1010, 1015  
 factors affecting, 982  
 observed impacts, 4-8, 7, 40, 42-43, 44-46, 49-51, 982, 996-1003, 1009-1010, 1015, 1017
- Human thermoregulation,** 713, 720-721
- Humboldt Current,** 1692-1693
- Hunger,** 796, 805
- Hurricanes**  
 in Central and South America, 1508, 1535, 1542  
 economic damages of, 383  
 Hurricane Katrina, 211, 381, 383, 810, 1002  
 Hurricane Mitch, 1535  
 Hurricane Rita, 381  
 Hurricane Stan, 621  
 Hurricane (Superstorm) Sandy, 383, 810, 1470, 1473  
 Hurricane Wilma, 1470  
 in North America, 1445, 1460, 1470  
*See also* Tropical cyclones
- Hydrological cycle\*,** 234, 249, 253
- Hydrological impact assessment,** 241
- Hydrological systems**  
 detection and attribution of impacts, 234-236, 235  
 extreme events, 236, 239-240  
 observed changes, 4, 7, 232, 234-240, 982  
 projected changes, 241-248, 253  
 projected extremes, 247-248, 248
- Hydropower,** 666, 667  
 in Asia, 1355  
 in Central and South America, 1519-1520, 1540-1541, 1544  
 in Europe, 1282  
 extreme events and, 666  
 freshwater resources and, 233, 252, 257-258  
 in North America, 1458, 1467
- Hyogo Framework for Action,** 217
- Hypoxia,** 150, 418-420, 443-445, 444  
 in coastal areas, 373  
 dead zones, 17, 373, 415, 420, 1676, 1693, 1709-1710  
 hypoxic effects, 464  
 hypoxic zones, 420, 464  
 in ocean systems, 415-416, 418-420, 443-445, 444, 464, 993, 1675-1676  
 tolerance, 415, 464
- Hypoxic events\*.** *See* Eutrophication
- I**
- Ice caps\*,** 987, 987
- Ice sheets\*,** 63, 190
- Impact assessment\*,** 213-214, 213, 1176-1184  
 baseline and scenario information, 1179-1184  
 climate model projections and, 171  
 delta method, 241  
 downscaling, 211-212, 1137-1138, 1159-1162  
 impact analyses, 1178-1179  
 methods, 241, 631  
 probability distributions, 241  
 scale in, 1149  
 top-down and bottom-up approaches, 1144, 1144
- Impacts\*,** 4-8, 7, 37-58  
 aggregate (*See* Aggregate impacts)  
 attributed to climate change, 30-32  
 avoided impacts, 1045, 1081-1083, 1081  
 cascading, 983, 1012, 1013, 1015-1016  
 of climate-related extremes, 40-42  
 definition of, 39, 1048  
 detection and attribution of, 7, 979-1037  
 direct and indirect, 720-722, 741  
 distribution of, 12, 61, 241, 254, 955-956, 1015, 1044, 1077  
 on ecosystem services, 319-321, 319  
 global pattern of regional impacts, 1010-1013, 1011  
 global patterns of, 43  
 interactions of, 1046  
 local, 1151  
 non-climate factors and, 40  
 observed (*See* Observed impacts)  
 regional, 7, 1001-1030, 1003-1010, 1147-1152, 1150, 1151  
 regional vs. other scales, 1150, 1151-1152, 1151  
 residual, 1080-1083  
 transboundary, 1042-1043, 1059-1062, 1062  
 valuation of, 617, 630-633, 632  
*See also* Observed impacts; Projections; *specific systems and regions*
- Incentives,** 949, 963-966
- Income inequality, global,** 802
- Incremental responses\*,** 733, 1106, 1121, 1445
- INDEPTH Network,** 715
- India**  
 agriculture, 1343-1344, 1351  
 air quality, 1353  
 caste system, 799, 807, 808  
 coastal population, 373  
 electricity production, 1353  
 exposure to storm damages, 1638  
 flood risk, 1346, 1347  
 forests, 1340  
 Ganges river runoff, 1337-1338  
 gender inequalities, 807  
 human health, 1347, 1348-1349, 1353  
 malaria, 1347  
 monsoons, 1333, 1334  
 trade, 1353  
 water resources, 1337-1338, 1344  
*See also* Asia
- Indian Ocean**  
 chlorophyll concentrations, 1660  
 climate projections, 1628-1629  
 sea surface temperature (SST), 1658, 1665  
 subtropical gyre, 1695
- Indigenous knowledge,** 182, 517, 520, 758, 765-766, 1001  
 adaptation and, 87, 765-766, 766  
 in Central and South America, 1531  
 in climate forecasting, 643  
 threats to, 766
- Indigenous peoples\*,** 758, 765  
 adaptation, 758, 765, 766  
 adaptation planning, 876  
 adaptive capacity, 765, 766  
 in Arctic region, 51, 983, 1016, 1581-1582, 1593-1595  
 in Australasia, 1375, 1405-1406, 1408  
 decision making, lack of inclusion in, 758, 765  
 detection and attribution, 983, 1001, 1002, 1003, 1014  
 health and well-being, 1581-1583, 1594, 1595  
 knowledge systems of, 213, 765-766

- livelihoods, 51, 765, 805, 983, 1003, 1010  
 mitigation actions and, 797  
 in North America, 1444, 1460, 1461, 1462, 1470, 1471-1472, 1478  
 observed impacts, 983, 1001, 1002, 1003, 1014  
 in polar regions, 983, 1016, 1571, 1581-1583, 1593-1595  
 poverty and, 797, 805-806  
 vulnerability/risk, 876
- Indonesian Throughflow**, 1671
- Industrialized countries\***, 181
- Industry**  
 coastal industries, 383-384  
 water supply for, 673  
*See also specific regions and countries*
- Inequality**, 6, 47-48  
 disadvantaged people, 796, 798, 799, 801-802, 806, 808  
 disproportionate climate impacts and, 797  
 equity and equity weighting, 926  
 exacerbation by climate impacts, 796  
 gender, 807-808  
 global income inequality, 802  
 high-income countries and, 802  
 livelihoods and, 799, 802  
 multidimensional, 6, 40, 47-48, 809-810, 809  
 multiple stressors and, 799  
 poverty and, 796, 802-803, 816, 1002  
 structural, 796, 802, 819  
 unequal distribution of mitigation benefits, 1111  
*See also Equity; Marginalization*
- Infectious diseases**, 663, 722-727  
 climate-related factors and, 723  
 floods and windstorms and, 722  
 thermal tolerance of vectors, 736  
*See also Diseases; Human health; Vector-borne diseases; Water-borne diseases; specific diseases*
- Informal settlements**, 538, 583, 805-806
- Information and communication technologies**, 884
- Information needs and options\***, 844, 845, 848
- Infrastructure**  
 adaptation, 847  
 in coastal areas, 364, 383-384, 993  
 costs of climate change, 383  
 costs of repairing, 628  
 critical, 72-73, 775  
 deterioration/damage of, 628  
 green, 90, 560, 572-575, 847, 884  
 human health and, 718, 736-737  
 in rural areas, 616, 628  
 state capacity and, 775  
 transportation, 628, 662, 674  
 in urban areas, 538, 539, 557, 560, 572-575  
 vulnerability/risk, 628  
 vulnerability to failure of, 737  
 water supply, 662, 672, 693  
*See also specific regions, sectors, and systems*
- Innovation**, 27, 909, 922, 966  
 climate resilience and, 1120-1121
- Insect pests**, 289-290, 320-321  
 forest infestations, 289-290, 1016, 1443, 1447, 1458, 1459  
 mountain pine and spruce beetles, 289-290  
 spread of, 303
- Insolation**, 1671
- Institutional capacity**, 1473
- Institutional change**, 1114
- Institutional learning**, 635
- Institutional needs\***, 843-844
- Institutional options\***, 836, 845, 848-849
- Institutional vulnerability**, 1068
- Institutions**, 27  
 adaptation constraints, 916-917, 922  
 adaptation options, 836, 845, 848-849  
 adaptation planning and implementation, 388-390, 389, 886-888  
 adaptation support, 1119-1120  
 barriers, 871, 886-888, 1351-1352  
 decision making and, 206-207, 1139  
 problems with, 1120  
 regional decision making and policies, 1139, 1140  
*See also Governance/government*
- Insurance\***, 680-687, 693, 949  
 adaptation and, 680, 872, 884, 885-886, 949, 964  
 adverse selection, 684  
 building standards for high-risk sites, 685  
 covering weather hazards, 680  
 crop insurance, 54, 685, 1147  
 diversification of large losses, 684, 685  
 flood insurance, 885  
 governance, public-private partnerships, and insurance market regulation, 686, 686  
 government, 663  
 impacts on insurance systems, 663, 680  
 index-based, 964, 1147, 1231  
 insurance systems, 663  
 microinsurance, 684, 816, 949  
 moral hazard, 964  
 observed and projected losses from weather hazards, 680-683, 681, 682  
 poor people and, 797, 816  
 prices, 682, 685  
 public-private risk prevention, 663  
 public sector as insurer of last resort, 949  
 reinsurance\*, 663, 684, 949  
 risk-adjusted premiums, 685, 886  
 risk financing, 686  
 risk-linked securitization, 663  
 risk management, 1403  
 risk transfer, 886  
 sovereign insurance, 685-686, 685  
 supply-side challenges and sensitivities, 683-684, 683  
 urban areas, 582-584  
 very large loss events, 684  
 weather disasters and, 663  
 weather risks, products responding to, 684-686, 685
- Integrated Assessment Models (IAMs)**, 925, 1148
- Integrated Coastal Zone Management (ICZM)\***, 365, 366
- Integrated Water Resource Management (IWRM)**, 254
- Intellectual property rights**, 966
- International trade**, 617, 629, 1171  
 sensitivity to climate, 1173-1175
- Invasive species and invasive alien species (IAS)\***, 15, 67, 275, 288-290, 289  
 in Australasia, 1397  
 observed changes, 275, 288-289, 990  
 projected changes, 275, 289-290, 289  
 in small islands, 1616, 1633
- IPCC Assessment Reports**, 4, 38, 169-126, 175  
 First Assessment Report (FAR), 174, 175  
 Second Assessment Report (SAR), 174-176, 175  
 Third Assessment Report (TAR), 175, 176  
 Fourth Assessment Report (AR4), 175, 176, 182-184  
 Fifth Assessment Report (AR5), 4, 38, 175, 176-182, 176-177  
 AR5 Guidance Note, 176, 176-177  
 certainty and uncertainty treatment in, 6, 7, 41, 176, 176-177  
 context for, 4, 38-39  
 evolution of WG II Assessments, 174-176, 175  
 information this report is based on, 174  
 literature, amount and authorship of, 38, 171, 172-174, 173, 174  
 major conclusions of AR4, 182-184  
 major conclusions of more recent reports, 184-192  
 science basis for, 172-174, 173  
 Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX), 187-188, 247, 620, 643, 680, 720, 1047-1049, 1163-1164  
 Special Report on Renewable Energy Sources and Climate Change Mitigation (SRREN), 165, 186, 187  
 Working Group I Fifth Assessment Report, 188-191  
 Working Group III Fifth Assessment Report, 191-192  
*See also specific reports*
- IPCC Working Groups**. *See* Working Group I; Working Group II; Working Group III
- Iron, in ocean fertilization**, 455
- Irreversible changes**. *See* Tipping points
- Irrigation**, 673-674  
 projections, 241  
 water demand for, 159, 251  
 water-saving, 1116  
 water use efficiency, 157-158  
 water use for, 233, 257
- Islands**. *See* Small islands
- J**
- Japan**  
 2011 Tohoku Earthquake Tsunami, 390  
 aging population in, 1332  
 coastal systems, 390, 1342  
 exposure to storm damages, 1638  
 food production, 1343-1344, 1345  
 rice production, 1343, 1344-1345  
 trade, 1353  
 transboundary pollution, 1353  
*See also Asia*
- Japanese encephalitis**, 725, 1348-1349
- Justice**, 180
- K**
- Kelp**, 364, 377-378, 992
- Key risks\***, 11-20, 21-25, 59-60, 114-121, 1069-1073  
 adaptation and, 1072-1073, 1080-1083  
 alternative development pathways and, 1044, 1052, 1072-1073  
 assessing, 1069-1071  
 assessment of response strategies, 1080-1085  
 criteria for identifying, 1051-1052  
 cross-chapter box, 113, 114-121

- dangerous anthropogenic interference, 11, 1043-1044, 1047, 1073
- definition of, 11-12, 1048-1049
- economic sectors, 59-60, 59-62, 64-65
- examples of, 1058, 1069-1071, 1070-1071
- food production and security, 114, 1058, 1069-1070
- freshwater resources, 232-233, 256
- global perspective on, 13
- human health, 116
- human security, 778
- livelihoods and poverty, 116-117, 811, 1058, 1070-1071
- mitigation and, 1080-1083, 1081
- ocean acidification, 60, 74-75, 1042, 1064, 1064, 1065, 1071, 1707-1708
- ocean systems, 114, 461-465, 462-463
- for poor people, 811
- Reasons for Concern, 1049, 1073-1080
- regional, 20, 21-25, 59-62, 76-80, 117-121
- rural areas, 115-116, 633-637
- terrestrial and inland water systems, 114
- urban areas, 114-115, 561-562, 591-596
- See also Emergent risks
- Key vulnerabilities\***, 59-60, 113, 117, 1039-1099
- assessing, 1052-1053
- criteria for identifying, 1051
- cross-chapter box, 113, 114-121
- definition of, 1048-1049
- differential vulnerability and exposure, 1066-1067
- environmental vulnerability, 1068
- factors in, 1065-1069
- framework for, 1050-1053
- historical development, 1046-1047
- institutional vulnerability, 1068
- new developments, 1049-1050
- previous assessment findings, 1046-1049
- Reasons for Concern, 1049, 1073-1080
- rural areas, 633-637
- socioeconomic vulnerability, 1067-1068
- SREX findings, 1047-1049
- trends in, 1067
- See also Key risks
- Knowledge**, 576, 576, 765-766
- access to, 629, 635
- adaptation and, 766
- adaptation constraints, 911-913
- indigenous, 182, 517, 520, 643, 765-766, 766, 1001
- local, adaptation and, 875
- traditional and local, 8, 629, 758, 765-766, 766
- traditional ecological (TEK), 1001
- Knowledge gap**, 565
- Knowledge transfer**, 198, 635
- Krill**, 1577, 1589, 1596
- Kyoto Protocol**, 257
- L**
- Lakes**
- eutrophication, 313
- glacial lakes, 242, 988, 1000, 1002
- lake ice, 987, 987
- observed impacts, 7, 30-32, 313, 1004
- See also Freshwater resources
- Land acquisitions, large scale (LSLA)**, 814-815, 1175
- Land degradation**, migration and mobility outcomes, 769-770
- Land-grabbing**, 73, 180, 630, 814-815, 1175
- Land use\***, 27
- for biofuel production, 630, 806-807, 814-815
- food production, 504-505, 504, 507
- human-modified systems, 317-319
- influence on climate change, 282
- land tenure systems, traditional, 635
- in rural areas, 616, 635, 637
- scenarios, 285
- Land use and cover change (LUCC)**, 274, 282, 283-285, 284-285
- Land use change\***, 66, 274, 284-285, 1502
- biofuel production and, 630, 797, 806-807, 814-815, 1055-1056, 1056
- carbon release by, 276
- in Central and South America, 1502, 1503, 1509-1510, 1513-1516, 1522-1523, 1534-1535, 1542, 1543
- in coastal areas, 372-373
- as driver of ecosystem change, 274, 1513
- effects on ecosystems, 277
- effects on terrestrial and freshwater ecosystems, 274, 277, 283-285, 284-285
- emergent risks, 1042, 1054, 1055, 1056
- freshwater resources and, 240-241
- privatization, 637
- summary of effects, 284-285
- Landslides**, 805, 987-988
- Large-scale interventions**, 1114
- See also Geoengineering
- Large-scale land acquisitions**, 814-815, 1175
- Large-scale processes and feedbacks**, 415
- Large-scale singular events**, 12, 61, 1015-1016, 1044, 1078-1080
- avoiding, 1084
- temperature and, 63
- Least Developed Countries (LDCs)**, 852, 874
- Leishmaniasis**, 385, 1223, 1536
- Leptospirosis**, 1532, 1536
- Likelihood\***, 6, 41, 177
- See also Confidence; Uncertainty
- Livelihoods\***, 20, 30-32, 39, 50-51, 73, 793-832
- adaptation actions, 762
- agricultural, 621-623
- agricultural productivity and, 810-812
- assessment of climate change impacts, 803-813
- assessment of climate change responses and mitigation, 813-816
- assets, 803-805, 812
- biofuel production and, 814-815
- climate-resilient development pathways, 818
- climate stressors and, 796
- critical thresholds, 798, 804
- definitions and scope, 798-799
- detection and attribution, 44-46
- dynamics, 805
- farming, 803
- financial assets, losses of, 805
- future impacts and risks, 810-813, 811
- gender and, 807
- impacts of adaptation responses, 815-816
- impacts of climate, weather, and climate-related hazards, 796
- indigenous peoples, 51, 765, 805, 983, 1003, 1010, 1595
- inequalities and, 799, 802
- insurance and, 797
- interactions with poverty, inequality, and climate change, 802-803, 804
- key risks, 116-117, 1058, 1070-1071
- land issues, 803
- mitigation policies and, 797
- mobility and, 758
- multiple stressors and, 50-51, 798-799, 799
- observed impacts, 6-8, 7, 30-32, 44-46, 803-810, 983, 1002-1003, 1002
- poverty and, 796, 1002
- projected impacts, 73
- REDD and, 797
- research gaps, 818-819
- resilience, 797, 818
- rural areas, 60, 616, 617, 623-628, 644, 796
- seasonal sensitivity, 806
- security, 27, 758, 761-762, 761
- shifts in, 796, 805, 812
- synthesis, 818-819
- trajectories, 796, 798, 799, 803, 805, 806, 812
- weather events and, 803-805
- Livestock**, 494, 502
- adaptation, 489, 517, 519-520
- adaptation options, economic evaluation of, 962
- in Central and South America, 512, 1515, 1528, 1530
- heat stress, 110, 517, 627
- observed impacts, 502
- projected impacts, 508-512, 625-627, 633
- temperature and, 502, 517
- water stress, 502
- Low regrets policies and actions\***, 66, 188, 233, 254, 637, 644-645
- Lyme disease**, 723, 725, 736
- M**
- Macroalgae**, 429, 440, 450
- Macroeconomic analysis**, 963
- Macroeconomic impacts**, 669-672, 670-671
- Madagascar**, 1688
- Mainstreaming**, 87, 948, 1351-1352, 1640
- barriers to, 1351-1352
- Maize**, 491, 492, 493, 1016
- observed changes, 7, 621, 982
- projected crop yields, 5, 17, 69, 505, 509-510
- sensitivity to climate change, 505
- temperature and, 498
- Maladaptation\***, 87, 837, 857-859
- adaptation planning and, 837
- avoiding, 254, 518
- causes of, 858-859
- definition of, 837
- examples and experiences, 858, 859, 1476
- screening for, 858-859
- Malaria**, 385, 722-723, 731
- in Africa, 722-723, 723, 1222-1223
- in Asia, 1349
- climatic drivers and, 723, 723
- future risks, 688
- geographic distribution, 722-723, 723
- health care costs, 689
- near-term future, 725
- observed changes, 1000
- in small islands, 1624
- thermal tolerance of vectors, 736
- transmission and vectors, 722-723, 1625
- Malnutrition**, 688, 689, 1530, 1537
- Managed systems**, 277, 324-325, 325
- detection and attribution, 996-1003, 1009-1010, 1015, 1017

- managing for resilience, 325  
 marine ecosystems, 453-456  
 observed impacts, 7, 996-1003, *1009-1010*, 1015, 1017
- Mangrove forests**, 992, *1145*, 1330, 1503, 1525-1526, 1527, 1621  
 adaptation experience, 52  
 carbon sequestration by, 90, 1155
- Manufacturing**, 677, 1283, 1468, 1532-1533
- Marginalization**, 6, 47-48, 154, 180, 796-797, 799, 799, 802, *802*, *809*
- Marine biogeography**, 123-127
- Marine ecosystems**, 414-415, 423-424, 441-443, 1658-1660, 1677-1701, 1706, *1711*  
 adaptation, 451-456  
 adaptation limits, 416  
 biodiversity, 64, 416, 453  
 changes due to climate change, *451*  
 climate change impacts, 424-451  
 climate change sensitivity, 423-424  
 coastal, 453  
 cumulative impacts of multiple drivers, 448  
 detection and attribution, 44-46, 459-460, *460*, 993-996, *993*, *994*, *1007-1008*  
 ecosystem-level processes, 441-443  
 ecosystem services, 414, 452-453, 461  
 ecosystem structure, 7, *433*, 461-464  
 extinctions, *451*  
 human activities, 451-456  
 importance of, *417*  
 large-scale processes and feedbacks, 415  
 multiple drivers, responses to, 445-448, *446*  
 observed changes, 7, 30-32, 44-46, 48, 414-416, 993-996, *993*, *994*, *1007-1008*  
 ocean acidification impacts, 17, 415  
 Oxygen Minimum Zones, 48, 415-416, 418-420, *426*, *443-444*, 451  
 in polar regions, *451*, *1594*  
 projected changes, 17, 69, 414-416, 457-459, *458*  
 temperature effects, 110, 427-432, *427*  
 upwelling, 149-152  
 vulnerability/risk, 60-62, 415, 453, 1043  
 See also Coastal systems; Fisheries; Ocean systems
- Marine exclusive environmental zones**, *1174*
- Marine fisheries**. See Fisheries
- Marine mammals**, 414, 449-450, 457, 1575-1576, 1588-1589
- Marine protected areas**, 99, 1526
- Markets**, 663, *688*  
 adaptation and, 663  
 computable general equilibrium (CGE) model, 689  
 impacts on, 689-690, *690*  
 insurance market regulation, 686, *686*  
 market-based instruments, 180-181, 965-966  
 market failures and missing markets, 955  
 non-market factors, 948, 951, 956, 958, 960, *961*, *962*, *963*  
 transmission of impacts across locations, *688*, 690
- Meat consumption**, 714, *742*
- Mediterranean region**. See Europe
- Mediterranean Sea**, 1684-1685
- Mediterranean-type ecosystems**, 312
- Mekong River/delta**, 803  
 dams, 1355  
 iliving with floods program, 640
- transboundary adaptation planning and management, 1355
- Mental health**, 722, 732, 1405  
 extreme events and, 805, 1537
- Methane**, 63, 739
- Metrics**, 631, 632-633, 853-857  
 for adaptation, 837, 853-857  
 criteria and indicators, *855*  
 established, 855-856  
 monetary and non-monetary, 631  
 monitoring and evaluation, 856  
 multi-metric decision making, *957*, *957*  
 multi-metric evaluations, *957*, *957*, 1118-1119  
 resource allocation, 855-856  
 validation of, 856-857  
 vulnerability, 854-855
- Mexico**, 1463  
 adaptation, *1448-1449*, *1474*  
 agriculture, 1463  
 extreme events and vulnerabilities, *1450*  
 GDP, *1451*  
 human population, 1448-1449  
 Mexico City, climate responses, *1474*  
 Mexico-USA border region, *1448-1449*, 1470  
 migration, 1449-1450  
 NAFTA, *1448*, 1450  
 observed and projected changes, 82  
 poverty, 1452  
 precipitation, 82  
 socioeconomic indicators, *1451*  
 temperature, 82  
 See also North America
- Microbes**, 415, 424, 428-429, 436  
 hypoxia and, 443  
 ocean acidification and, 439-440, 442  
 productivity, 447
- Micro-finance**, *584*
- Microinsurance**, 684, 816
- Middle East and North Africa (MENA)**, 803
- Migration**  
 assisted, 325-326, *325*, 328  
 migration corridors, 325-326, *325*  
 of natural systems, 1176  
 of species, 15, 69, 324  
 See also Range shifts
- Migration, human**, 65, 72, 758, 766-771, *769-770*, 1175-1176  
 ability to move, *768*  
 as adaptation strategy, *770-771*, *770*  
 climate change and, *766-767*, *768*  
 to coastal areas, 373, 805  
 definition of, *767*  
 environmental degradation and, 616, 628  
 environmental migrants, *771*  
 extreme events and, 65, 623  
 forced migration, 746, 1175-1176  
 health risks of, 736  
 human security and, 39, 758, 766-771, *769-770*, *777*  
 international policy and, *771*, *771*  
 multiple drivers of, 617, 621, 628  
 numbers of people displaced, *768*  
 pathways to, *767-768*, *768*  
 planned retreat, 39, 387, 389, 1375-1376  
 regional context, 1175-1176  
 risks, 1060  
 rural areas, 616, 617, 628, 635  
 rural-to-urban, *568*  
 sea level rise and, *770*, *770*
- small islands and, 1625, 1639-1640  
 trends and long-term climate change, 768-770  
 urban adaptation and, 563  
 vulnerability/risk, 1042, 1060
- Migration of natural ecosystems**, 1176
- Millennium Development Goals (MDGs)**, 800-801, 818, 1211
- Millennium Ecosystem Assessment**, 283, 300, 312, 319, 956-957
- Mining**, 163, 633, 676, 1399, 1467-1468
- Mitigation\***, 26, 1101-1131  
 adaptation and, 180-181, 216-218, *217*, 1080-1083, 1104, 1109-1110  
 adaptation limits and, 903  
 avoided impacts, 1045, 1081-1083, *1081*  
 biodiversity and, 1061-1062  
 Clean Development Mechanism (CDM), 813-814, 848-849, 1111  
 climate-resilient pathways and, 1104  
 co-benefits, 714, 737-741  
 consequences and costs of inaction, 326-327, *326*  
 decision processes, 216-218, *217*  
 development processes and, 1109  
 early, rapid, *1081*  
 geoengineering (See Geoengineering)  
 impacts on freshwater resources, 257-258  
 integration with adaptation, 1104, 1117-1118  
 limits to, 1083-1084  
 poverty and livelihoods and, 797, 813-815  
 REDD payments, 617, 630, 641, 797, 814, *965*  
 resilience and, 1113-1115  
 responses not compatible with sustainable development, 1110-1111  
 risk management through, 1080-1085, *1081*, 1104-1105  
 risks associated with, 1042-1043, 1059, 1060, 1061-1062  
 risks of delay in, 1105  
 scenarios, 1080-1083, *1081*, *1083*  
 scenarios, stringent, 1045, 1055, *1081*  
 terrestrial and inland water systems, 321  
 trade-offs, 216, 217, 925, 1104  
 unequal distribution of benefits, 1111  
 unintended consequences of, 277, 327-328, 1042-1043, 1059, 1060, 1061-1062  
 voluntary carbon offset (VCO), 814  
 win-win/triple-win approaches, 24, 27, 1111, 1117, 1118  
 Working Group III Fifth Assessment Report, 191-192  
 See also Adaptation; Adaptation and mitigation inter-relationships
- Mobility**, 758, 766-770, *769-770*  
 ability to move, *768*  
 See also Migration, human
- Models**. See Climate models
- Modes of climate variability\***, 1162, *1180*
- Molluscs**, 16, 68, 415, *438*, 452, 465  
 extinctions, 300
- Monsoons\***  
 in Africa, 1161-1162  
 in Asia, 1333, 1334  
 in Central and South America, 1506, 1509, 1511  
 North American Monsoon System, 1506  
 projected changes, 1162, 1334
- Montane ecosystems**. See Mountain regions
- Moral hazard**, 964

**Mortality**

- child mortality, 688
- cold-related (winter), 721, 983
- drought-related, 721
- extreme weather events and, 42, 720-722, 805
- gender and, 808
- heat-related, 42, 60, 110, 720-721, 736, 983, 1058, 1069, 1374

**Mosquito-borne diseases, 722-726**

See also Dengue fever; Malaria

**Mosquitoes, 718, 722, 725, 726, 736**

- Aedes* spp., 718, 725, 736
- Anopheles* spp., 722, 723, 1625

**Mountain regions**

- high mountain states, 797
- impacts and critical thresholds, 804
- montane ecosystems, 1375, 1381, 1401, 1411, 1413
- mountain farmers, 637
- observed impacts, 982, 987, 987, 989, 1000, 1003
- poverty in, 797
- regional impacts, 1003
- slope instability, 987, 987, 989
- vulnerability/risk, 298-299

See also High-altitude ecosystems

**Multi-metric decision making, 957, 957****Multi-metric evaluations, 957, 957, 1118-1119****Multinational corporations, 566****Multiple stressors, 6-8, 50-51, 276, 283-290**

- climate change adaptation and, 871
- regional context, 1138, 1181-1182
- scenarios and, 172
- vulnerability and, 179-180

**Musk oxen, 1581****Mussels, 415****Myanmar, cyclone impacts, 148****N****National Adaptation Programmes of Action**

(NAPAs), 180, 816, 836, 852, 873, 880, 1111

**National security policies, 758****Natural resources**

- conflict over, 617
- economic dependence on, 617, 623

**Natural systems**

- in coastal areas, 375-381
  - detection and attribution in, 986-996, 1015
  - migration, 1176
  - observed impacts, 40-50, 44-46, 986-996, 1014, 1015
  - trends in impacts, 1014, 1014
- See also Observed impacts; *specific systems and regions*

**Nature conservation, 674****Nature tourism, 663, 679****Navigation**

- inland navigation, 675-676
- in polar regions, 1173, 1174, 1584, 1591-1593, 1591, 1592, 1705

**Nepal, 799, 807****Net primary production (NPP), 133-136, 134**

- aggregate impacts, 1016
- boreal-tundra systems, 316
- carbon dioxide effects on, 292-293
- cross-chapter box, 133-136
- global, 133, 135, 460, 1714
- model projections, 134, 135

- ocean systems, 17, 35, 133-136, 415, 421, 424, 424, 425, 434, 443, 444-445, 456, 457, 458, 461, 462, 1659, 1697, 1699, 1707, 1714

- ozone and, 286
  - phytoplankton, 421, 1714
  - spatial trends in, 133-135
  - terrestrial systems, 276, 286, 292-293
- See also Primary production

**Netherlands**

- adaptation, 391
- coastal adaptation, 365, 391, 395
- government policies, 1157
- green infrastructure, 884

**New York City, 555, 595-596**

- climate responses, 1474
- extreme precipitation days, 1472
- green infrastructure, 884

**New Zealand. See Australasia****Nitrogen**

- deposition, 285-286, 989
- low availability of, 276
- negative effects on productivity, 286
- removal of fixed (denitrification), 416

**Nitrogen fixation, 447, 1065****Nitrogen oxides (NO<sub>x</sub>), 739****Nitrous oxide, 453****Non-climate stressors, 616, 1053, 1054, 1066-1067, 1070, 1513-1516****Non-climatic drivers of change\*, 240-241****Non-climatic factors, 40, 1050**

- use of (in oceans), 80, 1710

**Non-governmental organizations, 180, 617, 836****Nonlinear effects, 735-736****North America, 76-78, 1439-1498**

- adaptation, 23, 54, 91, 1445, 1472-1476, 1477, 1478
- adaptation challenges, 1443
- adaptation, evidence of, 1472-1473
- adaptation examples, 8, 1460-1462, 1474
- adaptation, federal and subnational, 1475-1476
- adaptation in ecosystems, 1460-1462
- adaptation opportunities, constraints, and limits, 922, 1443-1444, 1449, 1473-1475, 1476
- adaptation planning, 1445, 1473, 1476, 1478
- adaptation, transboundary context, 1448-1449
- adaptive capacity, 1448-1456, 1478
- agriculture, 1443, 1444, 1446-1447, 1462-1464
- air quality, 1464, 1465
- biodiversity, 1446, 1458-1462, 1460, 1475
- climate stressors, 1478
- climate trends, 1447, 1452-1456
- coastal areas/ecosystems, 1443, 1444, 1459-1460, 1470, 1477
- conclusions of AR4, 1446-1448
- construction and housing, 1468-1469
- crop yields, 510, 1444, 1462-1463
- cyclones, 1447, 1452-1454, 1459, 1460, 1477
- demographic and socioeconomic trends, 1448-1452
- detection and attribution, 45, 1003-1010, 1443, 1444, 1447
- droughts, 63, 247, 999, 1444, 1455, 1456, 1461, 1470, 1477
- early warning and response systems, 1466
- economic sectors and services, 1466-1469
- economy, 1444, 1445, 1451, 1471-1472

- ecosystems, 1443, 1446, 1458-1462, 1470, 1476, 1477, 1478

**elderly population, 1451, 1452****energy, 1466-1467**

- extreme weather events, 42, 1443-1445, 1447, 1450, 1470, 1472, 1478

**federal level adaptation, 1475****fires/wildfires, 1460-1461, 1477****fisheries, 1470**

- floods, 673, 721-722, 1444, 1445, 1456, 1457, 1476

**food security, 1462-1464****forest infestation, 1443, 1447, 1458, 1459****forestry, 1460, 1471, 1472, 1477****heat waves, 721, 1444, 1470, 1477****high-resolution climate change projections, 1162****human health, 1444, 1447, 1464-1466, 1477****human population, 1450-1452, 1451****human settlements, 1469-1475****hurricanes, 1445, 1460, 1470**

- indigenous peoples, 1444, 1460, 1461, 1462, 1470, 1471-1472, 1478

**infrastructure, 1443, 1444, 1445, 1472, 1478****institutional capacity, 1473-1475****insurance, 1469****key risks, 23, 78, 118-119, 1476-1477, 1477****livelihoods, 1444, 1472, 1476****livestock, 512****locally novel temperature regime, 1443****maladaptation, 1463, 1476****manufacturing, 1468****Mexico-USA border region, 1448-1449****migration, 1449-1450****mining, 1467-1468****multi-sectorial risks, 1476-1477, 1477****NAFTA, 1448, 1450****New York City, 555, 595-596**

- observed climate change, 81, 1443, 1452-1454, 1453

- observed impacts, 31, 42, 45, 1003-1010, 1443-1445, 1447, 1459-1460, 1478

**pollen, 1465-1466****poverty, 1451**

- precipitation, 81, 1443-1445, 1452, 1453, 1462, 1477

- precipitation extremes, 1455, 1456, 1470, 1472, 1477

- projected climate change, 81, 1443-1444, 1453, 1454-1456, 1455

**projected impacts, 76-78****risk management, 1445**

- risks, 1443-1444, 1448-1456, 1472, 1476-1477, 1477

**rural settlements, 1443, 1469-1475****sea level rise, 1443, 1444, 1454, 1477****slow-onset perils, 1445**

- snow/snowpack, 1443, 1452, 1454-1456, 1455, 1462-1463

**snowmelt, 1443, 1456, 1462-1463****socioeconomic indicators, 1451**

- spring advancement (phenology), 291-292
- storms and related impacts, 1443, 1444, 1452-1454, 1460, 1463, 1464, 1470

**streamflow, 1443, 1456****subnational adaptation, 1475-1476**

- temperature, 81, 999, 1443, 1444, 1452, 1453, 1472, 1477

- temperature extremes, 1444, 1452, 1455, 1456, 1463, 1464, 1477

- tourism, 636, 1471-1472  
 transportation, 1467  
 tree mortality and forest infestation, 1443, 1447, 1459  
 uncertainties, knowledge gaps, and research needs, 1477-1478  
 urban settlements, 1443, 1469-1475, 1476  
 vector-borne diseases, 1465  
 vulnerabilities, 1443, 1444, 1448-1456, 1470-1472  
 vulnerability hotspots, 1463  
 water-borne diseases, 1465  
 water management, 1456-1458  
 water quality, 1444, 1457, 1466, 1477  
 water resources, 1443-1444, 1446, 1456-1458  
 water supply, 1443-1444, 1456-1457  
 wildfires, 1460-1461  
*See also* Canada; Mexico; United States
- North American Free Trade Agreement (NAFTA)**, 1448, 1450
- North Atlantic**, 621, 1678-1679
- North Atlantic Oscillation (NAO)\***, 1162, 1180  
 marine ecosystems and, 420, 434  
 projected changes, 1162
- North Pacific**, HLSBS in, 1679-1680
- Northern Hemisphere**  
 spring advancement, 291-292  
 temperature, 434
- Norwegian Sea**, 1678-1679
- Nuclear power**, 662, 666, 667
- Nutrients**, 257, 286  
 in coastal systems, 364, 373, 380  
 interactive effects, 286  
 in ocean systems, 415-416, 420
- Nutrition**, 488, 730-731, 730  
 calorie intake/availability, 730-731  
 climate change impacts on, 730-731  
 effects on children (stunting and underweight), 731  
 healthy diets, 714  
 limits in, 736  
 malnutrition, 688, 689, 1530, 1537  
 meat consumption, 714, 742  
 near-term future, 730-731  
 nutrients, 488, 490, 501-502, 507  
*See also* Undernutrition
- O**
- Observed impacts**, 4-8, 7, 30-32, 37-58, 40-42, 44-46  
 aggregate impacts, 1015, 1016  
 all continents and zones affected by, 4, 40, 982, 1017  
 assessing all climate change aspects, 1017  
 biodiversity, 990  
 biological systems, 1015  
 cascading impacts, 983, 1012, 1013, 1015-1016  
 climate and non-climate drivers, 240-241  
 coastal systems and low-lying areas, 7, 991-993, 1007-1008  
 conclusions of AR4, 182-184, 984  
 confidence in, 184-185, 186  
 cryosphere, 982, 986-989, 987  
 detection and attribution (*See* Detection and attribution)  
 deviation from historical conditions, 982  
 emerging patterns, 1010-1017  
 extreme weather events, 998-1000, 999, 1014, 1014  
 floods, 7, 59, 232, 248  
 food production systems, 7, 996-997, 1017  
 freshwater resources, 7, 234-240, 986-989, 987  
 gaps in knowledge and research needs, 983, 1017  
 global pattern of regional impacts, 1010-1013, 1011  
 human and managed systems, 7, 996-1003, 1009-1010, 1017  
 human health, 50, 720-722, 741, 1000  
 hydrological systems, 7, 986-989, 987, 1013, 1015, 1016  
 indigenous people, 983, 1001, 1002, 1003, 1014  
 livelihoods, 7, 983, 1002-1003, 1002  
 major systems, 7, 990-991  
 natural systems, 7, 986-996, 1014, 1015  
 ocean acidification, 982  
 Ocean region, 1658-1660, 1664-1677, 1706  
 ocean systems, 7, 993-996, 993, 994, 1007-1008  
 physical systems, 7, 982, 984, 994, 1011, 1012  
 productivity and biomass, 7, 989-990  
 regional impacts, 7, 1001-1030, 1003-1010, 1147-1148  
 regional water balance, 988  
 sensitivity to climate and adaptation, 997  
 species distribution, 990  
 synthesis, 1010-1017  
 terrestrial ecosystems, 7, 982, 983, 989-991, 1005-1006, 1017  
 water resources, 982, 986-989, 987  
*See also* specific regions and countries
- Occupational health**, 731-732
- Ocean acidification\***, 74-75, 129-131, 374, 426, 464-465, 1658-1659, 1673-1675, 1673, 1707-1708, 1710, 1714  
 acclimation and gene regulation, 439  
 analogues of, 129  
 in Australasia, 1374, 1379, 1393, 1413  
 biotic responses to, 415  
 calcifiers and, 129, 364, 368, 464-465, 1042  
 cause of, 74  
 chemistry of, 129  
 coastal impacts, 364, 368, 370, 372  
 conclusions of AR4, 190  
 coral bleaching and, 80, 98, 364, 1689  
 cross-chapter box, 129-131  
 detection and attribution, 1662  
 economic impacts and costs, 129  
 fisheries, impact on, 507, 676  
 impacts of, 129-131, 415, 436, 437, 439, 993, 1064, 1064  
 interactive effects, 416  
 Ocean Acidification Effects (OAEs), 464-465  
 overview, 74-75, 130  
 pathways of impacts, 74-75, 1064, 1064  
 policy options for action, 130  
 projections, 69, 129-131, 368, 379, 415, 416, 450, 1673  
 responses to, 131, 437-439, 438-439  
 risks from, 60, 74-75, 1042, 1064, 1064, 1065, 1071, 1707-1708  
 tolerances to, 437  
 variability in, 418  
*See also* Coral bleaching; Coral reefs
- Ocean fertilization**, 454, 455
- Ocean (region)**, 80-84, 1655-1731  
 adaptation, 8, 1660, 1698-1706  
 adaptation options, 25, 1703, 1703, 1707-1708, 1711-1712  
 aquaculture, 1701-1704  
 Basin Scale, 1667  
 biodiversity, 1707  
 biological systems, 1699, 1711-1712  
 Blue Carbon, 1660, 1699-1701  
 carbon absorption and storage, 1658, 1697-1698, 1705-1706  
 carbon dioxide flux, 420, 993, 1660  
 carbonate chemistry, 1658, 1673-1675, 1682-1683  
 chemical changes, 1673-1677  
 chemical systems, 1699  
 chlorophyll concentrations, 1660  
 circulation and currents, 1658, 1671  
 climate variability, 1658-1659, 1713  
 Coastal Boundary Systems (CBS), 1663, 1666, 1686-1690  
 conclusions from previous assessments, 1662-1664  
 Coral Reef Provinces, 1667, 1669  
 coral reefs, 80, 1659, 1682, 1689, 1707  
 dead zones, 1676, 1693, 1709-1710  
 Deep Sea, 1660, 1663, 1697-1698, 1705-1706  
 detection and attribution, 1662, 1698, 1699  
 Eastern Boundary Upwelling Ecosystems (EBUE), 149, 1659, 1663, 1666  
 economic sectors, 1701-1705  
 emerging issues, data gaps, and research needs, 1713-1715  
 energy industry, 80, 1660, 1705  
 Equatorial Upwelling Systems (EUS), 149, 1659, 1663, 1666, 1681-1683  
 extreme events, 1659  
 fisheries, 1659-1660, 1663, 1699, 1701-1704, 1707-1708, 1708  
 food webs, 1714-1715  
 frameworks for decision making, 1661, 1711-1713, 1711-1712  
 Global Partnership for Oceans, 1713  
 global patterns of marine organism responses, 1677  
 heat content and temperature, 1664-1668, 1665-1667  
 High-Latitude Spring Bloom Systems (HLSBS), 1659, 1666, 1677-1681, 1703-1704  
 human health, 1705  
 impacts, potential to reverse, 1675  
 industries, 1660  
 international frameworks and agreements, 8, 54, 1661  
 key risks, 25, 80, 121, 1707-1709, 1708-1711, 1711-1712  
 livelihoods, 1659-1660, 1709  
 marine ecosystems, 7, 1658-1660, 1677-1701, 1706, 1711, 1714-1715  
 marine organisms, distribution and abundance, 48, 1658, 1677-1698, 1707, 1708, 1711-1712, 1714  
 marine spatial planning, 8, 1660, 1708  
 maritime security, 54, 1706  
 mitigation, 1705-1706  
 multiple stressors, 1658-1659  
 natural ecosystems, 1699-1701  
 net primary productivity, 133-136  
 non-climate factors, use of, 80, 1710  
 observed changes, 1658-1660, 1664-1677, 1706  
 ocean acidification, 1658-1659, 1673-1675, 1673, 1707-1708, 1710, 1714

- ocean circulation, 1658, 1671  
 offshore energy and mineral extraction, 1660, 1705  
 oxygen concentration, 1675-1677, 1676, 1697-1698, 1707, 1709-1710, 1714  
 pH, 68, 993, 1658, 1673-1675, 1673  
 physical changes, 1664-1672  
 physical systems, 1699  
 precipitation, 1707-1708, 1712  
 productivity/NPP, 17, 35, 133-136, 1659, 1660, 1672, 1677-1698, 1682, 1714  
 projected changes, 1658-1660, 1664-1677  
 projected impacts (examples of), 1700  
 regional changes and projections, 1664-1677  
 regional impacts, risks, and vulnerabilities, 1658, 1677-1698  
 renewable energy, offshore, 1660, 1706  
 resilience, 1715  
 role in Earth's climate, 1658  
 sea level, 1660, 1668-1670, 1707-1708  
 sea surface temperature (SST), 1658, 1664, 1665-1668  
 sectoral impacts, adaptation, and mitigation, 1698-1706  
 Semi-Enclosed Seas (SES), 1659, 1663, 1666, 1683-1686  
 shipping, 80, 1660, 1705, 1709  
 solar insolation, 1671  
 storm systems, 1660, 1671, 1710, 1712, 1713-1714  
 sub-regions, 1658, 1662, 1663, 1677-1698  
 Subtropical Gyres, 1663, 1666, 1693-1697  
 surface salinity, 1658, 1672, 1673  
 surface wind, 1660, 1671, 1706, 1710  
 synthesis and conclusions, 1706-1715  
 temperature, 60, 1658-1659, 1664-1668, 1665-1669, 1707-1708, 1708  
 temperature extremes, 110, 1707-1708, 1708-1709  
 thermal stratification, 80, 1658, 1672, 1710  
 thermal stress, 1669  
 tourism, 1704-1705  
 UN Straddling Fish Stocks Agreement (UNSFSA), 1713  
 United Nations Convention on the Law of the Sea (UNCLOS), 1661, 1711-1713  
 vulnerabilities, 1677-1698, 1700  
 waves, 1660, 1671  
 winds, 1658, 1659, 1660, 1671, 1713-1714
- Ocean systems, 411-484**  
 adaptation capacity/limits, 414, 415, 416  
 adaptation, human activities and, 451-456  
 adaptation, local, 430-431  
 adaptation, management-related, 453-456  
 adaptation opportunities, constraints, and limits, 922  
 adaptation responses, 415, 451-456  
 animals, 427-428, 427, 428, 429-430, 440-441, 443, 447  
 anoxia, 415-416, 443-445  
 benthic habitats and ecosystems, 125, 150, 422, 424, 443-444, 448, 449  
 biodiversity, 64, 416, 451, 453  
 biogeochemistry, 417, 420-421, 424, 424, 436, 451, 459  
 biological pump, 424  
 biota, 415, 416, 456  
 birds, 414  
 body size, 414, 429, 430, 458, 459  
 carbon dioxide effects on, 415, 418, 432-443, 450  
 carbon dioxide flux, 420, 993, 1660  
 carbon storage in, 454, 455  
 circulation, 1671  
 climate change impacts, 417-418, 417, 424-451, 426  
 climate regulation, 453, 456  
 climate variability, 414, 419  
 conclusions, 461-465  
 conclusions of AR4, 190  
 coral communities, 431  
 cross-chapter box, 123-127  
 cultural services, 453  
 detection and attribution, 459-460, 460, 994-996, 995  
 ecosystem projections, 457-459, 458  
 ecosystem services, 414, 452-453, 461  
 ecosystems, 414-415, 431-432, 433, 441-444, 448, 451  
 extinctions, 451, 456  
 extreme events, 453  
 fisheries, 414-416, 435, 452-453  
 food production, 452-453, 456  
 food web, 424, 448, 449, 459-460  
 freshwater input, 426, 435, 442  
 geoenvironment, 416, 454, 455  
 health and diseases, 415, 431-432, 454-455  
 historical and paleo-records, 420-423, 422  
 human systems/activities and, 416, 451-456  
 hypoxia, 150, 415-416, 418-420, 443-445, 444, 447, 464, 993  
 key risks, 114, 461-465, 462-463  
 key uncertainties, 465  
 large-scale processes and feedbacks, 415  
 light and, 420, 444-445  
 macroalgae, 429, 440, 450  
 macrophytes and macrofauna, 442  
 marine biogeography, abundance, and phenology, 123-127  
 marine mammals, 414, 449-450, 457  
 microbes, 415, 424, 428-429, 436, 439-440, 442, 447  
 mixed layer depth, 444-445, 444  
 modelling approaches, 456-460, 457  
 multiple drivers, responses to, 416, 445-448, 446, 459, 465  
 nutrients, 415-416, 420, 442  
 observed impacts, 414-416, 417-423, 982, 993-996, 993  
 Oxygen Minimum Zones\*, 48, 415-416, 418-420, 426, 443-444, 451  
 paleoclimate (fossil) evidence, 414  
 pelagic biomes and ecosystems, 150, 424, 434-435, 993, 1016  
 pH, 68, 993, 1658, 1673-1675, 1673  
 phenology, 123-124, 430, 431, 432  
 physical, chemical, and biological properties, 414, 418-420, 419, 982, 994, 994  
 plants, 427-428, 427, 428, 447  
 predator-prey dynamics, 48, 414, 431, 432, 450  
 production/productivity, 133-136, 415, 416, 423, 429, 444-445, 450, 451, 453, 456, 457, 459, 461, 993  
 projected changes and impacts, 414-416, 417-418, 456-460  
 reptiles, 414, 448-449  
 salinity, 414, 418, 431, 435, 1658, 1672  
 sea surface temperature, 433  
 seabirds, 414, 449-450, 457  
 seagrasses, 415, 429, 440, 442, 450  
 socioeconomic impacts, 414, 416, 459  
 species abundance, distribution, and migration, 7, 48, 49, 123-125, 414-415, 416, 430, 431, 448, 451, 456, 459, 461-464, 982, 994, 994  
 species interactions, 414, 431, 432, 450, 459  
 species responses to changing variables, 430, 450  
 species-specific responses to warming, 415, 430, 450  
 supporting services and transport, 453  
 temperature effects, 414-416, 418, 419, 427-432, 427, 1071  
 temperature, responses to, 49, 434-435  
 thermal sensitivity, 48, 60, 414, 415, 416, 431-432, 432, 446  
 thermal windows/ranges, 427-428, 427, 428, 450  
 trophic levels, higher, 456-457  
 trophic mechanisms, bottom-up, 149  
 upwelling, 149-152, 416, 442, 465, 995-996  
 vulnerability, 414-416  
 See also Marine ecosystems; Ocean acidification
- Opportunity space, 88, 181-182, 182**
- Oxygen**  
 concentration (in oceans), 1675-1677, 1676  
 critical threshold, 443  
 dissolved oxygen, 1675-1677, 1676
- Oxygen deficiency. See Hypoxia**
- Oxygen Minimum Zones\*, 48, 415-416, 418-420, 426, 443-444, 451**
- Oysters, 415, 464**
- Ozone\*, 286-287, 728-729**  
 air quality and, 1171, 1172  
 effects on crop yields, 488, 493, 499  
 ground-level, 729  
 human health and, 716, 728-729, 728  
 methane and, 739  
 negative effects of current levels, 286-287  
 stratospheric, 499  
 trends, 739  
 tropospheric, 286-287, 488, 493, 716, 728-729
- P**
- Pacific Decadal Oscillation (PDO)\*, 421, 993**
- Pacific North American (PNA) pattern, 1180**
- Pacific Ocean**  
 chlorophyll concentrations, 1660  
 North Pacific, HLSBS in, 1678-1679  
 sea surface temperature (SST), 1658, 1665  
 subtropical gyres, 1694-1695
- Pacific Walker Circulation, 1180, 1671**
- Pakistan, 503**  
 See also Asia; Bangladesh
- Paleoecological evidence, 274, 279-282**  
 abrupt climate change, 421-423  
 ocean systems, 421-423, 422  
 Paleocene-Eocene Thermal Maximum, 422, 423
- Palm oil, 1515, 1533**
- Parasites, 726-727**
- Paris agglomeration, 957, 957**
- Particulates\*, 728, 728**
- Pastoralism\*, 625, 644, 766**  
 coping/adaptation strategies, 636-637  
 poverty and, 806-807



- Payment for ecosystem services (PES)**, 90, 641-642, 964, 965, 1523, 1540-1541, 1541
- Peat/peatlands\***, 258, 313-314  
in Asia, 258, 1341, 1350, 1352, 1353  
carbon stocks in, 313-314
- Pelagic biomes and ecosystems**, 150, 424, 434-435, 993, 1016
- Pelagic communities**, 1016  
range shifts in, 435
- Pelagic fisheries**, 150, 384, 1016, 1702
- Penguins**, 457
- Permafrost\***, 314-315, 315  
aggregate impacts, 1016  
carbon stocks, 63, 314-315  
conclusions of AR4, 190  
degradation of, 314-315, 315, 1016  
detection and attribution, 982, 987-988, 987, 1016  
infrastructure and, 662  
observed changes, 7, 236, 982, 987-988, 987  
in polar regions, 1570, 1594, 1595  
projected changes, 243, 314-315, 315  
thawing, 63, 64, 304  
vulnerability, 305
- Pests**, 289-290, 320-321, 1459  
effects on carbon cycle, 276  
food production and, 500, 506-507  
forest insect infestations/damage, 289-290, 1016, 1443, 1447, 1458, 1459
- pH, oceanic**, 68, 993, 1658, 1673-1675, 1673  
See also Ocean acidification
- Phenology\***, 123-124, 274, 291-292  
adaptation and, 321-322  
drivers of change, 292  
freshwater resources and, 232  
observed changes, 291-292, 322, 982, 989, 1000  
in ocean systems, 123-124, 430, 431, 432  
projected changes, 274, 322
- Philanthropic engagement**, 584-585
- Photosynthesis**, 133, 276, 288, 424, 429, 1409  
CO<sub>2</sub> effects on, 307, 415, 494
- Physical systems**, 982, 984, 994, 1011, 1012  
detection and attribution, 42  
observed impacts, 7, 42-43
- Phytoplankton**, 417, 431, 438-439, 453, 1596  
adaptation in, 75, 130  
biomass, 434-435, 445  
blooms, 291, 444, 445, 455, 455, 1681  
carbon sequestration and, 425, 1699  
chlorophyll concentrations, 421, 424, 457  
community structure, 423, 424, 442, 1711  
distribution changes, 43, 69, 428, 431, 434, 447  
fisheries and, 456-457  
food webs and, 424, 448, 451  
in freshwater systems, 286, 287, 291, 313  
global NPP percentage due to, 1714  
light and nutrients, 286, 420, 444-445, 455, 1681  
observed impacts, 7, 46  
ocean acidification and, 69, 74, 130, 439, 439, 442, 1696-1697  
ocean upwelling and, 1710  
paleo-records, 423  
in polar regions, 32, 445, 1678, 1681  
productivity, 32, 46, 421, 431, 435, 444-445, 451, 457, 1680-1681, 1682, 1714  
projected impacts, 17, 69, 457, 457  
season peaks, 1680-1681  
temperature and, 427, 428, 435, 455  
See also Algal blooms; Zooplankton
- Pilot Program on Climate Resilience**, 844, 879
- Pine and spruce beetles**, 289-290
- Pipelines**, 71, 668, 669, 675
- Plague**, 723, 725, 1000
- Planetary boundaries**, 902
- Plankton**, 414, 415, 435  
ocean acidification and, 69, 74  
See also Phytoplankton; Zooplankton
- Planned adaptation**. See Adaptation planning and implementation
- Plants**  
anthropogenic climate change and, 288  
C<sub>3</sub> and C<sub>4</sub> plants, 287-288, 310-311, 500, 505  
carbon dioxide effects on, 157, 159, 293, 303, 308  
diseases, 500  
hypoxia and, 443, 447  
multiple drivers, responses to, 447  
oceanic, thermal windows for, 427-428, 427, 428  
ozone and, 286-287  
primary production by, 276, 286, 292-293  
range shifts, 274, 279  
spring advancement (phenology), 291-292
- Plasmodium spp.**, 722
- Polar bears**, 317, 990, 1016, 1570, 1575-1576, 1588, 1596
- Polar regions**, 80, 1567-1612  
adaptation, 8, 24, 1570-1571, 1594  
adaptation opportunities, constraints, and limits, 922, 1570  
animal populations, 1580-1581  
Arctic (See Arctic region)  
biomass production, 1571  
climate change impacts, 1570  
detection and attribution, 46, 1003-1010  
economic sectors, 1584-1586, 1590-1593  
economy, 1585  
ecosystem shift, 1576  
ecosystems, 1570  
fish/fisheries, 1584, 1590-1591  
forestry and farming, 1591  
freshwater ecosystems, 234, 1570, 1572-1573, 1586-1587, 1594  
human adaptation, 1593-1595  
human health, 1581-1583, 1594, 1595  
hydrology, 1572-1573, 1586-1587  
indigenous peoples, 1571, 1581-1584, 1593-1595  
infrastructure, 1570, 1584-1585, 1591, 1594  
interconnected factors, 1570  
key risks, 24, 79, 119-120, 1594  
krill, 1577, 1589, 1596  
livelihoods, 1595  
map of, 1572  
marine ecosystems and services, 451, 1594  
marine mammals and seabirds, 1575-1576, 1588-1589  
marine transport, 1584  
multiple stressors, 1572-1586  
new evidence on, 1570-1571  
observed changes, 314, 1572-1586  
observed impacts, 32, 46, 1003-1010, 1570  
ocean acidification, 17, 69, 1571, 1587  
oceanography, 1574-1577, 1587-1589  
permafrost, 1570, 1594, 1595
- phenology, 1571, 1574, 1578, 1578, 1588-1589  
phytoplankton, 32, 445, 1570, 1596, 1678, 1681  
polar bears, 1570, 1575-1576, 1588, 1596  
production, 1574-1575, 1596  
projected changes, 314  
projected impacts, 1571, 1586-1593  
rapid rate of change, 1570  
research and data gaps, 1595-1596  
resource exploration, 1585, 1593  
sea ice, 1570, 1591-1593, 1591, 1594, 1595, 1596, 1681  
socioeconomic impacts, 1595  
Southern Ocean, 1585-1586, 1589  
species shifts, 1570, 1571, 1574  
temperature, 1573  
terrestrial ecosystems, 1570, 1577-1581, 1589-1593  
traditional knowledge, 1583-1584  
transportation/navigation, 1173, 1174, 1584, 1591-1593, 1591, 1592, 1705  
upwelling, 1576  
vegetation, 1578-1580, 1579  
vulnerabilities/risks, 276, 414, 1572-1586, 1586-1593  
See also Antarctica; Arctic region
- Policy decisions**  
for adaptation, 89-90, 171, 909, 922, 948-949  
information for, 171  
low regrets, 188, 233, 254, 637, 644-645  
in regional context, 1139, 1140  
Shared Policy Assumptions (SPAs), 1143
- Pollen**, 1000, 1043, 1056, 1064, 1465
- Pollination/pollinators**, 320-321, 1054
- Pollution**  
climate-altering pollutants, 713, 714, 715, 716, 728, 728  
transboundary, 1353  
See also Air pollution
- Population**. See Human population
- Ports**, 557, 558, 572, 675-676  
in Central and South America, 1524, 1525
- Poverty\***, 50-51, 793-832  
adaptive capacity and, 816  
agricultural impacts and, 810-812  
assessment of climate change responses and mitigation, 813-816, 813  
assessment of impacts, 803-813  
chronic, 796, 801, 803, 805-806, 812-813  
Clean Development Mechanism (CDM) and, 797, 813-814  
climate-resilient development pathways, 818  
climate-resilient pathways, 797  
critical thresholds, 807-809  
definitions and scope, 798, 799-801  
densely-populated coastal cities, 803  
differences in impacts on, 796  
dimensions of, 799-801  
disproportionate impacts associated with, 796, 802-803, 816, 1002  
dynamics, 805-806, 812, 818  
extreme event impacts, 802  
financial assets, losses of, 805  
food insecurity and, 491, 797, 806  
food price increases and, 796, 802, 812  
future impacts and risks, 810-813, 811  
geographic distribution, 801  
human health and, 805

- impacts of adaptation responses, 815-816  
 impacts of climate, weather, and climate-related hazards, 796, 802-803, 802, 983  
 indigenous peoples, 797, 805-806  
 inequalities and, 802  
 informal settlements, 805-806  
 insurance and, 797, 816  
 interactions with livelihoods, inequality, and climate change, 802-803  
 International Poverty Line, 800  
 key risks, 116-117, 811  
 land use and, 797, 806-807, 814-815  
 lessons from climate-development efforts, 816-818, 817  
 measuring, 799-801, 800  
 middle-income countries, 801, 819  
 mitigation policies and, 797  
 multidimensional, 797, 800-801, 800  
 multiple deprivations and, 796  
 net buyers of food, 797, 802  
 new poor, 796, 803  
 new vulnerabilities, 796  
 observed evidence, 796, 1002-1003, 1002  
 pastoralism and, 806-807  
 pockets of, 797  
 positive climate change impacts, 796  
 poverty indicators, 623, 624  
 projections, 801, 810-813, 811  
 REDD and, 797, 814  
 research gaps, 818-819  
 risk-prone locations, 803-805  
 in rural areas, 616, 618, 618, 621, 623, 806  
 spatial and temporal scales, 801  
 sustainable development and, 796, 816  
 synthesis, 818-819  
 transient, 805-806, 812-813  
 trends, 801  
 vulnerability and, 796, 797, 802
- Poverty reduction**, 27, 89-90, 796, 800-801, 815, 819  
 adaptation and, 948  
 implications of climate change for, 816-818
- Poverty traps\***, 20, 692, 796, 806-809, 812-813  
 critical thresholds, 807-809, 812-813  
 debt load, 807  
 minimum asset threshold, 801  
 new, 796
- Precipitation**  
 conclusions of AR4, 189  
 drivers of change, 240-241  
 extremes, 59, 239-240, 1070, 1162-1163, 1163-1170  
 Giorgi-Francisco regimes, 1160  
 heavy precipitation events, 81-84, 1136  
 observed changes, 57-58, 140, 236, 1136, 1153, 1165-1170  
 projected changes, 57-58, 81-84, 140, 307-308, 1136-1137, 1152-1154, 1158-1159, 1159-1160, 1162-1163, 1163-1170  
 projected extremes, 240, 246, 1162-1171, 1163-1170  
 projected impacts and interactions, 240-241  
 projections, regional, 1159, 1160  
 RCP projections, 140  
 regional impacts, 1153, 1154, 1158-1159, 1160-1161  
 variability, 60, 1070  
 See also Droughts; Floods; specific regions and countries
- Predator-prey dynamics**, 48, 414, 431, 432, 450
- Pregnancy**, 718, 740-741
- Pre-industrial temperatures**, 735  
 warming to 2°C above, 735  
 warming to beyond 2°C above, 735, 735, 736
- Price rises**, 568, 623, 625, 730, 796, 1059-1060  
 See also Food prices
- Price stability**, 488, 628
- Price volatility**, 491, 495, 513, 628
- Primary production**, 286, 292-293  
 carbon dioxide effects on, 276, 287, 292-293  
 fisheries, 150, 416, 489, 493  
 in freshwater ecosystems, 286, 293, 493  
 nitrogen/nutrients and, 286  
 observed changes, 286, 982, 989-990  
 ocean acidification and, 129  
 in oceans, 17, 133-136, 415-416, 423-424, 424-425, 431, 434, 440, 443, 444-445, 447, 448, 449, 450, 451, 452, 455, 456-459, 457, 461, 508, 1658-1660, 1663, 1671, 1672, 1677, 1680-1697, 1682  
 by phytoplankton, 32, 46, 421, 431, 435, 444-445, 451, 457, 1680-1681, 1682, 1714  
 by plants, 276, 292-293  
 in terrestrial systems, 292-293, 294, 311, 319  
 upwelling ecosystems, 149-150  
 See also Net primary production (NPP)
- Private sector engagement**, 539-540, 582-584, 836, 843-844  
 in adaptation, 8, 871, 876, 876, 880-881, 886, 948, 950
- Probability distributions (of future impacts)**, 241, 254
- Productivity/production**. See Net primary production (NPP); Primary production
- Projections\***, 11-25, 21-25, 59-60, 59-84, 63-65, 76-84  
 Arctic sea ice, 60, 623, 776, 987, 987, 1015-1016, 1071, 1591-1593, 1591, 1595, 1712  
 downscaled, 1159-1162  
 global, 1136-1137  
 high-resolution projections, 1162, 1181-1182, 1182  
 impact models, 1148  
 regional, 81-84, 1136-1137, 1148-1152, 1152-1154, 1158-1171, 1159-1160, 1163-1170  
 regional summary figures, 137-141, 138-140  
 scenario-based, 213  
 sea level rise, 366, 368-369, 369, 633, 1137, 1171, 1669-1670  
 sea level rise, global, 1137  
 temperature and precipitation, global, 10, 1137  
 temperature and precipitation, regionally, 1153, 1154  
 temperature, projected changes, 10, 57-58, 81-84, 182, 1153, 1154  
 uncertainties, 1138  
 See also Key risks; Temperature projections; specific sectors, regions, and systems
- Property and property rights**, 761, 762, 773-774, 779
- Protected areas**, 324, 1524, 1526  
 marine protected areas, 99, 1526
- Psychological effects**. See Mental health
- Pteropods**, 415, 440-441
- Public health**, 714, 718, 733, 738
- Public-private partnerships**, 686, 686, 949
- Public sector**, 8, 948, 950  
 as insurer of last resort, 949
- Public services**, 575
- R**
- Radiation**, 288, 722
- Radiative forcing\***, 178, 179, 188-189
- Rail transportation**, 572, 675
- Rainfall**. See Precipitation
- Rainfed agriculture**, 251-252, 498, 499, 514, 616, 624, 634
- Range shifts**, 4, 44, 69, 274, 294-296, 1176  
 in Asia, 1339-1340  
 climate velocity and, 15, 125, 126  
 coastal areas, 364, 376, 377, 378, 992  
 observed changes, 294-296  
 in oceans, 124-125, 414-416, 430, 431, 450, 451, 456, 994, 1677-1698, 1707, 1708, 1711-1712, 1714  
 projected changes, 296-299, 297  
 risks associated with, 1042, 1061, 1075
- Reasons for Concern\***, 12, 61, 1013-1016, 1073-1080  
 aggregate impacts, 12, 61, 1015, 1016, 1044, 1077-1078  
 climate change and exposure, 13, 1074  
 conclusions of AR4, 182-184  
 dangerous anthropogenic interference, 11, 1049, 1073  
 definition, 1049  
 distribution of impacts, 12, 61, 1015, 1044, 1045, 1077  
 extreme weather events, 12, 61, 1014, 1014, 1044, 1045, 1076  
 large-scale singular events, 12, 61, 1015-1016, 1044, 1078-1080  
 mitigation scenarios and, 1083  
 socioeconomic pathways and, 1074-1075  
 summary of, 983, 1044, 1049  
 temperature and, 1073, 1074  
 unique and threatened systems, 12, 61, 1013-1014, 1013, 1044, 1045, 1075-1076  
 updating, 1044, 1073-1080  
 warming beyond 2°C, 924
- Recreation**, 677-678, 679  
 in coastal areas, 384-385  
 urban areas, 560  
 See also Tourism
- Red Sea**, 1683-1684
- REDD (Reducing Emissions from Deforestation and Degradation)**, 617, 630, 641, 797, 814, 965, 1111, 1119
- Reforestation\***, 277, 317, 321, 1062
- Regime shifts**, 454, 1015-1016, 1079
- Regional context**, 137-141, 1133-1197  
 about: regions, with chapter numbers and map, 1142  
 abrupt and irreversible changes, 276  
 adaptation, 73-84, 1152-1157  
 adaptation assessment, 1176-1184  
 adaptation examples, 8-9, 90-91, 1145-1148, 1155-1156  
 adaptation studies, variations in, 1137  
 air quality projections, 1171, 1172  
 baseline information, 138, 1179-1181

- climate change impacts perspective, *1144*  
 climate information for political and economic regions, *1157*  
 climate models, *1136, 1137-1138*  
 climate summary figures, *137-141, 138-140*  
 climate system, *1158-1162*  
 context, *1139-1144*  
 cross-chapter box, *137-141, 138-140*  
 cross-regional phenomena, *1137, 1171-1176*  
 decision-making context, *1136, 1139, 1140*  
 defining, *1140-1143, 1141-1142*  
 detection and attribution, *7, 30-32, 42, 44-46, 1001-1030, 1003-1010*  
 distribution of impacts, *1015, 1015*  
 downscaling, *1137-1138, 1159-1162*  
 extreme climate events, *1162-1171, 1163-1170*  
 extreme hydrological events, *247-248, 248*  
 financial flows, *1171-1172*  
 global context, *1158-1159*  
 global pattern of regional impacts, *1010-1013, 1011*  
 global scenarios, new framework for, *1143*  
 globally averaged observed and projected changes, *1136-1137*  
 hotspots, *1137, 1177-1178*  
 human migration, *1175-1176*  
 hydroclimatic regimes, *1162*  
 impacts, *7, 30-32, 1137, 1147-1152, 1151*  
 impacts assessment, *1149*  
 indicators, *1177*  
 information available, *1136-1137, 1144*  
 institutions and actors, *1139*  
 key risks, *20, 21-25, 59-62, 76-80*  
 knowledge gaps and research needs, *1183, 1184*  
 main topics, *1142-1143*  
 methods, *1144*  
 migration of natural ecosystems, *1176*  
 modes of variability, *1162, 1180*  
 multiple stressors, *1138, 1181-1182*  
 observed changes, *81-84, 1136-1137, 1158-1171*  
 observed impacts, *7, 44-46, 1001-1030, 1003-1010*  
 previous assessments, *1136*  
 previous assessments, and current report, *1150*  
 projected changes, *81-84, 137-141, 138-140, 1136-1137, 1152-1154, 1158-1171, 1159-1160, 1163-1170*  
 projected impacts, *1138, 1148-1152*  
 projections, models and information for, *1136-1137*  
 projections, variation in, *1137*  
 regional assessment, scenarios for, *1143*  
 regional circulation, *1162*  
 regional variation, *1137*  
 reliability of approaches, *1176-1184*  
 reliability of information, *1147, 1150*  
 resilience, enhancing, *1145-1148*  
 resolution of models, scenarios, and projections, *1137-1138, 1162, 1181-1182, 1182*  
 risk management on 20-year time horizon, *1156*  
 risks, *73-84, 1136*  
 scale issues, *1149, 1151-1152*  
 scenario information, *1137-1138*  
 sea level, *369, 1171*  
 seasonal and annual changes, *1152, 1154*  
 similarities and differences in regions, *1155*  
 summary figures, *137-141, 138-140*  
 synthesis of key issues, *1144-1151*  
 synthesis of projected changes in extremes, *1163-1170*  
 temperature and precipitation, *138, 1153, 1154, 1158-1159, 1160-1161*  
 trade, *1171-1175*  
 uncertainty, *1138*  
 vulnerabilities, *1136, 1144, 1144, 1147-1152*  
 vulnerability assessment, *1149, 1176-1184*  
 vulnerability indicators, *1137, 1177*  
 vulnerability mapping, *1151, 1152*  
 vulnerability perspective, *1144*  
 vulnerability reduction, examples, *1145-1148*
- Regional chapters**  
 Africa, **1199-1265**  
 Asia, **1327-1370**  
 Australasia, **1371-1438**  
 Central and South America, **1499-1566**  
 Europe, **1267-1326**  
 map of regions, *1142*  
 North America, **1439-1498**  
 Ocean, **1655-1731**  
 Polar Regions, **1567-1612**  
 Small Islands, **1613-1654**  
*See also specific regions*
- Reindeer**, *1580, 1594-1595*  
**Reinsurance\***, *663, 684, 949*  
*See also Insurance*
- Relative sea level**. *See* Sea level
- Renewable energy**, *91, 617, 629-630, 1503, 1533-1535, 1534, 1544-1545*  
 IPCC Special Report on (SRREN), *165, 186, 187*  
 in small islands, *1641-1642*
- Representative Concentration Pathways (RCPs)\***, *139-140, 171, 178, 179*  
 coastal systems, *367*  
 human health projections, *713*  
 land use scenarios, *285*  
 projections for small islands, *1629, 1630-1631*  
 regional assessments, *1143*
- Reproductive health services**, *740-741, 742*  
**Reptiles**, marine, *414, 448-449*  
**Research & development funding**, *948, 966*  
**Reservoirs**, sedimentation of, *373-374*  
**Residential sectors**, *662, 671, 676*  
**Residual cost**, *952-953, 953*  
**Residual impacts**, *1080-1083, 1204*  
**Resilience\***, *28-29, 85-93, 1101-1131*  
 boundaries of the envelope of, *1123*  
 building, *85-93*  
 climate change responses and, *1113-1118*  
 climate velocity and, *62, 87-88, 1121*  
 in coastal systems, *365*  
 co-benefits, *1104, 1118*  
 concepts in, *1104, 1106, 1121*  
 decision making and, *182, 198, 216-217, 1118*  
 definition of, *40*  
 determinants of, *1121-1123*  
 economic growth and, *1114-1115*  
 enhancing, *1110*  
 in face of serious threats, *1121-1122*  
 incremental responses, *1106, 1121*  
 innovation and, *1120-1121*  
 long-term, *147-148*  
 mitigation and, *1104, 1113-1115, 1117-1118*  
 political transformation, *1121-1122, 1122*
- range of options, *1120-1121*  
 regional examples, *1145-1148*  
 research and knowledge gaps, *1105, 1124-1125*  
 risk management and, *1104-1105, 1117-1118*  
 socio-technical transformation, *1105, 1120-1121*  
 sustainable development and, *198, 216-217, 1104, 1118-1121*  
 trade-offs, *1104, 1118-1119*  
 transformation change and, *2-16, 1107, 1121-1122*  
 from tropical cyclone disasters, *147-148*  
 in urban areas, *18, 538, 539, 548-549, 550, 560-563*  
 urban-rural interactions and, *154*  
 window of opportunity, *1124*
- Resilience: Climate-resilient pathways\***, *28-29, 87-93, 1101-1131*  
 adaptation and, *1104, 1115-1117*  
 alternative pathways, *1122-1123*  
 case study (China), *1116*  
 categories of response, *1106*  
 co-benefits, *1104*  
 decisions and, *1118*  
 definitions, *1104, 1106, 1106, 1107*  
 delayed action, results of, *1105, 1123-1124*  
 elements of, *1104, 1112-1113, 1113, 1121-1122, 1122*  
 framing, *1112*  
 goals for, *1107*  
 innovation and, *1120-1121*  
 institutions and, *1119-1120*  
 mitigation and, *1104*  
 moving toward, *1105, 1122-1124*  
 now as the time for, *1105, 1123*  
 opportunity space, *88*  
 political transformations and, *1105, 1121-1122, 1122*  
 range of options, *1104, 1120-1121*  
 research needs, *1105, 1124-1125*  
 risk management and, *1104*  
 sustainable development and, *28, 87, 1104, 1108-1113, 1110, 1118-1121*  
 technology and, *1114, 1120-1121*  
 transformations and, *29, 88, 1105, 1119-1120*
- Resource pricing**, *964-965*
- Rice**, *5, 17, 49, 1330-1331, 1343-1345, 1344, 1347, 1349, 1354, 1354, 1355, 1528-1529*  
 observed crop yields, *7, 491, 492*  
 prices, *568*  
 projected crop yields, *5, 17, 49, 75, 488-489, 505, 509-510, 1330-1331, 1343-1345, 1344, 1504*  
 temperature and, *498, 1330, 1344-1345*
- Rice landscapes**, *318*  
**Rift Valley Fever**, *1223*  
**Rio+20 (2012)**, *818*  
**Risk\***, *3, 26*  
 acceptable, *1047*  
 amplification by climate change, *63, 1057*  
 assessment (*See* Risk assessment)  
 climate change pathways and, *9*  
 compound risk, *1042, 1057-1059, 1058, 1412*  
 conclusions of AR4, *182-184*  
 core concepts, *3, 37, 85*  
 definitions of, *40, 199, 1048-1049*  
 drivers of, *633-634*  
 emergent risks\*, *59-60, 117, 1039-1099*

- exposure (See Exposure)  
 financing, 686, 949  
 freshwater-related, 248-253, 249  
 geoengineering, 454, 455, 1043  
 governance and, 538-539  
 hierarchy of, 202  
 interactions of, 3, 1046  
 key risks\*, 11-20, 21-25, 59-60, 114-121, 1069-1073  
 methodologies, 199-200  
 new, creation of, 63  
 newly assessed, 1062-1066  
 perceptions of\*, 28, 1068-1069  
 projected, 59-60, 59-84  
 Reasons for Concern, 12, 61, 983, 1013-1016, 1073-1080  
 risk-based framework for adaptation, 902, 905-908, 906  
 risk pools and sharing, 949, 964  
 in rural areas, 633-637  
 systemic, 59, 60, 1070  
 temperature (See Key risks)  
 tolerable and intolerable, 88, 906, 906  
 transboundary, 1042-1043, 1059-1062, 1062  
 types of, 201  
 in urban areas, 538-540, 547-549, 549, 550-563  
 vulnerability and, 1050  
 See also Emergent risks; Key risks; Vulnerabilities
- Risk assessment\***, 3, 3-4, 55-56, 684, 983, 1052  
 evidence for, 11  
 Reasons for Concern\*, 983, 1013-1016  
 scenarios and, 254-255  
 tools, 922
- Risk financing**, 686, 949
- Risk-linked securitization**, 663
- Risk management\***, 25-29, 26, 27, 56, 85-93, 86, 680  
 climate forecasts and, 643  
 climate-resilient pathways and, 1104, 1106  
 coastal systems, 365, 386-396  
 decision making and, 198, 199-202, 201  
 disaster risk reduction, 217, 390, 565-566, 565  
 feedbacks in, 9  
 freshwater resources, 253-258  
 in Ho Chi Minh City, 958  
 iterative process of, 56, 183, 198, 200-202, 201  
 mitigation and, 14  
 overlapping approaches, 86  
 regional, on 20-year time horizon, 1156  
 resilience and, 1104-1106, 1117-1118  
 sustainable development and, 1117-1118  
 See also Disaster risk management
- Risk prevention**, 663
- Risk transfer\***, 886, 949, 964
- River discharge\***, 625  
 See also Runoff
- River flow regimes**, 143-146, 144
- Rivers**, 274, 312-313  
 air temperature impacts, 144  
 cross-chapter box (flow regimes), 143-146  
 dams on (See Dams)  
 floods, 66, 721  
 flow regimes, 143-146, 144  
 impacts and vulnerability, 143-146, 312-313  
 mean annual flow, 144  
 observed impacts, 7, 30-32, 44-46, 1004  
 projected changes, 313  
 river basins, transboundary, 776  
 river ice, 232, 987, 987
- water temperature, 144-145, 313  
 See also Freshwater resources; Runoff; *specific rivers*
- Roads**, 572, 674-675, 1467
- Robustness**, 949, 957-958, 958
- Rodent-borne diseases**, 725, 1000
- Rooftops, green and white**, 90, 574-575
- Rotavirus infection**, 726
- Runoff\***, 143-146, 243  
 climate variability and, 158  
 coastal systems impacts, 364, 368, 372  
 from glaciers, 242  
 nutrients in, 257  
 observed changes, 237, 313, 987, 987  
 projected changes, 243, 245, 257, 372  
 river flow regimes and, 143-146  
 species richness and, 145
- Rural areas**, 19, 50, 70, 613-657  
 access to credit, 617, 642, 643  
 access to knowledge, 629, 635, 643  
 access to resources, 635, 642  
 access to water, 634  
 adaptation, 617, 637-643, 642, 644-645, 922  
 adaptation, decision making for, 638  
 adaptation experience and examples, 638-642, 639-640  
 adaptation limits and constraints, 617, 642-643  
 adaptation planning, 215-216  
 adaptive capacity, 617  
 agricultural adaptation, 638, 639-640  
 agricultural impacts, 616, 623-625, 631-632, 632  
 agriculture, 616, 617, 621-625  
 climate forecasts, 643  
 climate policies, 617, 629-630  
 conservation agriculture, 638  
 context of climate change, 616  
 cross-chapter box, 153-155  
 definition of, 616, 618-619, 619, 644  
 detection and attribution of impacts, 616, 619-621  
 distinctive characteristics of, 618  
 droughts, 616, 620-621  
 economic base, 616, 617, 623-628  
 economic transformation, 616  
 extreme weather events, 616, 620-621, 623, 633  
 farm households and communities, 616  
 fisheries, 627-628, 632-633, 637, 642, 644  
 food crops, 616, 623-625  
 food security, 616, 623-625, 628-630  
 forestry and biodiversity, 640-642  
 gender and, 617, 635, 644  
 governance and, 617  
 high-value food crops, 625  
 human health, 623  
 human population in, 616, 618, 618, 622  
 impact assessment, 619-637  
 incomes, 616  
 infrastructure, 616, 627  
 investment, 629  
 key conclusions, 643-645  
 key vulnerabilities and risks, 115-116, 633-637  
 knowledge and traditional knowledge, 629, 635  
 land tenure systems, traditional, 635  
 land use, 616, 635, 637  
 livelihood shifts, 796  
 livelihoods, 50, 60, 616, 617, 623-628, 644
- livestock, 625-627, 633  
 major impacts, 616, 619-637, 644  
 marginalization of, 154  
 market orientation, 634  
 migration, 616, 617, 623, 628, 635  
 mining, 633  
 multiple non-climate stressors, 616  
 natural resources and, 617, 623  
 non-food crops, 625  
 observed impacts, 50, 616, 619-623  
 pastoralists, 625, 636-637, 644  
 poverty in, 616, 618, 618, 621, 806  
 poverty indicators, 623, 624  
 projected impacts, 19, 70, 623-633, 796  
 recreation and tourism, 633, 636  
 REDD, 630, 641  
 research gaps, 645  
 resilience, 50, 616, 630, 634, 637, 638, 644  
 rural-urban migration, 568  
 salinity and saltwater intrusion, 633  
 scale of farms, 617, 623, 634  
 smallholder and subsistence farmers, 617, 623, 627, 634, 638  
 spatial and regional interconnections, 628-630, 644  
 storms, 616  
 summary of previous assessments, 619, 620  
 trade and, 70, 616, 617, 623, 628-629  
 transportation, 628  
 tropical beverage crops, 625, 626-627, 641  
 under-investment, 616  
 urban-rural interactions, 153-155  
 valuation of impacts, 617, 630-633, 632  
 vulnerabilities and risks, 616, 619-637  
 vulnerability outcomes, 635  
 water-dependent activities, 616, 625, 638-640  
 water supply and resources, 19, 65, 616, 625, 632-633, 638-640, 640
- Russia**  
 forest fires, 305, 729, 999  
 heat wave of 2010, 503, 729, 999
- S**
- Safety nets**, 27, 539, 836, 845
- Salinity (of oceans)**, 414, 418, 431, 435, 1658, 1672, 1673
- Salinization**  
 in coastal regions, 370, 379, 991  
 of groundwater, 633, 991
- Salmonella**, 726
- Salmonellosis**, 688
- Saltmarshes**, 377
- Sanitation and sewage**, 252-253  
 health aspects, 714  
 in urban areas, 538, 557-558
- São Paulo, Brazil**, 1532
- Savannas**, 308-311
- Scenarios\***, 56, 176-179, 179, 1179-1184  
 baseline, 138, 1179-1181  
 comparison of SRES and RCP, 178, 179  
 credibility of, 1181-1184  
 downscaling, 241  
 evolution of, 172  
 mitigation, 1080-1083, 1081, 1083  
 mitigation, stringent, 1045, 1055, 1081  
 regional assessment, 1143, 1179-1184  
 Representative Concentration Pathways (RCPs), 139-140, 171, 178, 179, 285, 367, 1143

- Shared Socioeconomic Pathways (SSPs), 171, 178-179, 367, 1143
- socioeconomic elements, 1183-1184
- SRES, 171, 367
- SRES CMIP3, 178, 179, 1143
- Schistosomiasis**, 727, 727, 1223-1224, 1536
- Scopus bibliographic database**, 173, 174
- Sea ice**
- Arctic, 60, 623, 776, 987, 987, 1015-1016, 1071, 1136, 1570, 1591-1593, 1591, 1595, 1712
  - conclusions of AR4, 190
  - importance of changes in, 1596
  - in polar regions, 1570, 1591-1593, 1591, 1594, 1595, 1596, 1681, 1712
  - risks and vulnerabilities, 1071
- Sea level**, 1660, 1668-1670, 1707-1708
- extremes, 191, 368, 370, 991
  - global mean sea level\*, 364, 368-369, 369, 1137, 1668-1669
  - local, 369-370, 991
  - regional, 369, 1171
  - relative sea level\*, 364, 367-370, 375
- Sea level change\***, 59, 63, 1668-1670
- adaptation options, economic evaluation of, 962
  - coastal area impacts, 364, 366, 367-370, 368, 374, 375, 379, 381, 385
  - commitment to, 1376
  - conclusions of AR4, 190-191
  - global mean sea level rise, 364, 368-369, 369
  - key risks and vulnerabilities, 1070, 1075, 1707-1708
  - large temperature increase, effect of, 63
  - long-term commitment to, 394-395
  - migration and mobility outcomes, 769-770, 770
  - observed changes and impacts, 7, 367, 368, 375
  - projected changes and impacts, 366, 368-369, 369, 633, 1137, 1171, 1669-1670
  - rate of rise, 1668-1669
  - regional impacts, 7
  - regional variations in, 364, 369
  - relative sea level rise, 367-370, 375
  - sanitation facilities and, 253
  - scenarios, 369
  - urban areas and, 538, 555
  - See also specific regions and countries*
- Sea surface temperature (SST)\***, 1658, 1664, 1665-1668
- climate velocity and, 126
  - coastal systems and, 368, 371-372
  - extremes, 371-372
  - observed changes, 371
  - ocean systems and, 418, 419, 433
  - projected changes, 372, 418
  - regional changes, 1666-1667
  - velocity of isotherm shifts, 1668
- Sea urchin (*Diadema*)**, 1633-1634
- Seabirds**, 414, 448-450, 457, 1577
- in polar regions, 1575, 1588-1589
- Seagrasses**, 415, 429, 440, 442, 450, 992, 1330
- in coastal areas, 377-378
  - in small islands, 1621-1622
- Seals**, 1016, 1596
- Seasonality**
- animal and plant species, 274, 291-292
  - climate indices and, 1180
  - freshwater resources, 232
  - See also* Phenology
- Second Assessment Report**, 174-176, 175
- Sectors**. *See* Economic sectors and services
- Sediment delivery**, 364, 369, 373-374, 982
- Sediment load**, 233, 237-239, 379, 380
- projected changes, 246-247
- Seed banks**, 326
- Sensitivity\***
- climate sensitivity, 423-424, 450, 997
  - thermal sensitivity, 48, 49, 431-432, 432, 446
- Sequestration**. *See* Carbon sequestration
- Services**
- adaptation options, 845, 847
  - ecosystem (*See* Ecosystem services)
- Settlements**. *See* Human settlements
- Shared Policy Assumptions (SPAs)**, 1143
- Shared Socioeconomic Pathways (SSPs)**, 171, 178-179, 367, 1143
- Shellfish**, 64, 1701
- cholera and, 726
- Shipping**, 80, 1173, 1174, 1584, 1591-1593, 1591, 1592, 1705
- trans-Arctic, 453, 1584, 1705
- Shrublands**, 4, 20, 279, 311-312
- Single weather events, attribution of**, 998-1000, 1018
- Sinks\***. *See* Carbon sinks
- Ski industry**, 71, 636, 663, 678, 679, 693, 998
- adaptation, 636
  - snow-making, 636
- Small islands**, 80, 1613-1654
- adaptation, 8, 24, 1616-1617, 1634-1640, 1635, 1636
  - adaptation and mitigation interactions, 1616-1617, 1641-1642
  - adaptation barriers and limits, 922, 1640
  - adaptation costs, 1626, 1639, 1644
  - adaptation experience, 53, 1636-1640
  - adaptation, facilitating, 1642-1643
  - adaptation financing, 1617
  - adaptation options, 1703
  - adaptation risks, 1634-1640
  - adaptation support, 1703
  - adaptation, transfer of lessons learned, 1642
  - adaptive capacity, 1617, 1636-1637
  - aquatic pathogens, 1616, 1624-1625, 1633-1634
  - atolls, 1616, 1618, 1619-1622, 1619, 1623, 1634
  - beach erosion, 1620, 1624
  - biodiversity, 1622
  - ciguatera fish poisoning, 1624-1625, 1634
  - coastal areas, 1616, 1619-1622, 1627, 1635
  - coastal squeeze, 1623
  - coastal wetlands, 91, 1616, 1621-1622
  - collective and cooperative action, 1638-1639, 1642
  - community-based adaptation, 54, 1146
  - conclusions from previous assessments, 1618-1619
  - coral reefs, 1616, 1621, 1628, 1635
  - detection and attribution, 46, 1004-1010, 1620, 1626, 1627, 1644
  - diseases, 1624-1625
  - dust, airborne transcontinental, 1616, 1633
  - economic development, 1703
  - economies, 1625-1626, 1626, 1628, 1635
  - ecosystems, 1621-1622, 1635
  - energy, 91, 1641-1642
  - erosion, 1620-1621
  - extreme events, 1635
  - fisheries, 1616, 1621, 1629
  - food security, 1703
  - freshwater lens, 1623
  - freshwater supply, 1622-1623
  - human health, 1624-1625, 1634
  - human settlements, 1620, 1623
  - human systems, 1623-1626, 1627
  - hydro-meteorological hazards, 1634, 1637, 1638
  - inundation, 1620
  - invasive species, 1616, 1633
  - island coasts, 1619-1622
  - key risks, 24, 79, 120, 1635
  - livelihoods, 1616, 1632, 1635, 1703
  - loss of land, 803
  - mainstreaming, 1640
  - maladaptation, avoiding, 1642-1643
  - management risks, 1634-1640
  - marine biophysical systems, 1619-1622
  - migration, 1625, 1639-1640
  - multiple stressors, 1616
  - observed impacts, 32, 46, 1004-1010, 1616, 1619-1626
  - ocean acidification, 1621, 1634, 1635
  - ocean waves, distant-source, 1616, 1630-1632
  - precipitation, 1616, 1622-1623, 1627, 1630-1631, 1635
  - projected impacts, 17, 1004-1010, 1626-1629
  - projection methods, 1626-1627, 1643-1644
  - RCP projections, 1629, 1630-1631
  - relocation, 1625, 1639-1640
  - renewable energy resources, 1641-1642
  - research and data gaps, 1643-1644
  - risk avoidance, 1638
  - risks, 24, 79, 120, 1616, 1635
  - risks, addressing, 1616, 1635, 1637-1638
  - saline intrusion of groundwater, 1623
  - scenario-based projections, 1626-1629, 1628, 1643-1644
  - sea level rise, 364, 775, 1616, 1619-1620, 1621-1622, 1627, 1634, 1635, 1639
  - sea surface temperature, 1616, 1635
  - shoreline change, 1619-1621
  - socioeconomic stressors, adaptation and, 1636
  - temperature, 1616, 1622, 1627-1629, 1630-1631, 1635
  - terrestrial systems, 1622-1623, 1627
  - tourism, 91, 1623-1624, 1627, 1638
  - trade-offs, 1616, 1618, 1641
  - traditional knowledge, 53, 1146, 1636-1637
  - transboundary impacts, 1616, 1629-1634
  - tropical and extra-tropical cyclones, 1616, 1632, 1635
  - tuna fisheries, 1629
  - Tuvalu, 777
  - types and characteristics of, 1616, 1619, 1634, 1644
  - vulnerabilities, 1616, 1618, 1625, 1635-1636
  - water resources, 1622-1623
  - waves, 1616, 1630-1632
- Small to medium enterprises (SMEs)**, 836, 843
- Snow cover**, 4, 7, 30-32, 190, 232, 315, 1003
- in North America, 1443, 1452, 1454-1456, 1455, 1462-1463
  - observed impacts attributed to climate change, 44-46

- Social capital**, 1473
- Social cost of carbon (SCC)\***, 690-691, 691
- Social needs**, 841-842
- Social options (for adaptation)**, 836, 845, 847-848
- Social protection\***, 797, 817
- Social safety nets**, 539, 836, 845
- Socio-ecological systems**, 278
- Socio-technical transformation**, 1105, 1120-1121
- Socioeconomic change**, 912
- Socioeconomic factors, interactions with risk and vulnerability**, 11, 26, 1046
- Socioeconomic impacts**  
in coastal systems, 372-373, 382, 383  
floods, 239  
of geoen지니어ing, 416  
human health, 718  
in ocean systems, 414, 416, 459
- Socioeconomic pathways**, 26, 171, 178-179, 367, 1074-1075, 1143
- Socioeconomic scenarios\***, 171, 178-179, 367, 1143, 1183-1184
- Socioeconomic vulnerability**, 1067-1068
- Soil erosion**, 233, 237-239, 246
- Soil moisture**, 236, 239, 241-243  
observed changes, 236  
projected changes, 232, 247, 249
- Solar insolation**, 1671
- Solar power**, 327, 666, 667-668
- Solar radiation management (SRM)**, 416, 454, 455, 776  
risks of, 1043, 1065-1066
- Solution space**, 85
- Somali Current**, 1687-1688
- South America**. See Central and South America
- South China Sea**, 1687
- Southeast Asian Seas**, 1687
- Southern Ocean**, 1585-1586, 1589  
mammals and seabirds, 1577  
sea ice extent, 1596  
temperature, 421  
wind stress, 1671  
See also Polar regions
- Sovereign insurance**, 685-686, 685
- Soy/soybeans**, 7, 491, 492, 493, 500, 1503, 1504, 1515, 1527, 1528, 1535  
projected impacts, 5, 17
- Spatially restricted populations**, 275
- Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation**. See SREX
- Special Report on Renewable Energy Sources and Climate Change Mitigation (SRREN)**, 165, 186, 187
- Species community composition**, 67, 274, 415, 451, 465, 994
- Species distribution**, 123-125, 124, 125  
coastal areas, 376, 377, 982  
human activities and, 298  
observed changes, 274, 294-296, 990  
ocean systems, 4, 7, 48, 124-125, 414-415, 416, 430, 431, 448-450, 456, 459, 461-464, 994  
projected changes, 274, 296-299, 297  
spatially restricted populations, 275
- Species extinctions**. See Extinction
- Species interactions**, 414, 459  
predator-prey dynamics, 48, 414, 431, 432, 450
- Species movements**, 274, 275, 324  
anthropogenic transport, 275  
limits to, 275  
ocean systems, 414-415, 416
- Species range shifts**, 44, 69, 124-125, 125, 274, 294-296, 1176  
climate velocity and, 15, 125, 126  
coastal areas, 364, 376, 377, 378, 992  
observed changes, 294-296  
oceans, 124-125, 414-416, 430, 431, 450, 451, 456, 994, 1677-1698, 1707, 1708, 1711-1712, 1714  
projected changes, 296-299, 297  
risks associated with, 1042, 1061, 1075
- Species responses, constraints on**, 48, 275
- Species thermal sensitivity**, 48, 49
- Sphagnum moss**, 313
- Spring advancement**. See Phenology
- SRES scenarios\***, 171, 367  
CMIP3, 178, 179, 1143  
compared with RCP, 178, 179
- SREX (Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation)**, 187-188, 247, 620, 643, 680, 720, 1047-1049  
summary of findings, 1163-1164
- SRREN (Special Report on Renewable Energy Sources and Climate Change Mitigation)**, 165, 186, 187
- Stakeholders**, 182, 837, 842  
involvement in decision making, 199, 209, 254, 580  
participation, 540, 837, 1473-1475
- States, integrity of**, 72-73, 775-777
- Storm surges\***, 364, 368, 370, 381, 453, 1070  
in Asia, 147, 148  
projected changes, 364, 370  
projected impacts, 370  
regional variability, 370
- Storms**  
coastal systems and, 364, 368, 370  
conclusions of AR4, 190  
frequency and intensity of, 1669-1670, 1710  
health impacts, 721-722  
impacts on water resources, 257  
in Ocean regions, 1660, 1671, 1710, 1712, 1713-1714  
Superstorm Sandy, 383, 810, 1470, 1473  
See also Hurricanes; Tropical and extratropical cyclones
- Storylines**, 176
- Strategic Environmental Assessment**, 254
- Strategic Programmes for Climate Resilience**, 1111
- Streamflow**, 243  
climate change impacts on, 232  
observed changes, 232, 236-237, 239-240  
projected changes, 243, 244  
seasonal changes in, 232, 243, 244
- Stressors\***. See Multiple stressors; Non-climate stressors
- Stunting**, 731
- Subsidies**, 949, 965-966
- Subsistence agriculture\***, 503, 616, 623, 627, 634, 638, 797
- Sugarcane**, 1503, 1528, 1533, 1534, 1540, 1544  
byproducts, 163
- Sulfur (as air pollutant)**, 739-740
- Sulfur dioxide**, 739-740
- Supply and demand**, 662, 664, 679
- Supply-side challenges and sensitivities**, 683-684, 683
- Surface temperature**. See Temperature
- Surface water**, 66, 232, 233, 250-251
- Sustainable development\***, 1101-1131  
adaptation and, 1109-1110  
adaptation and mitigation links, 216-217, 217, 1109-1110  
climate change as threat to, 816, 1104, 1108-1113  
climate change effects and reasons for concern, 1109  
climate change interactions with other factors, 1109-1110  
climate change, links to, 1108-1112  
climate change response/decision making, 198  
climate-resilient pathways and, 28, 1104, 1108-1113, 1110, 1118-1121  
current, threats to, 1104  
economic growth, tensions with, 1118  
freshwater resources, 233  
future, threats to, 1104  
goals and objectives of, 1108-1109, 1111  
institutions and, 1119-1120  
interactions with CCAV, 179-182  
local institutions, 1120  
mitigation responses not always compatible with, 1110-1111  
resilience and, 216-217, 1108-1113, 1118-1121  
risk management, 1117-1118  
strategies and choices, 1118-1121, 1123-1124  
Sustainable Development Goals, 818  
temperature rises and, 1123  
threats to, 816, 1104, 1108-1113  
trade-offs, 1118-1119  
transformative action, 1119-1120  
in urban areas, 18, 538-539, 560-563  
See also Resilience
- Synergies**, 28, 87, 89-91, 394, 948
- T**
- Taxes**, 949, 965-966
- Tea**, 626-627
- Technology**, 27  
access to, 1204  
adaptation and, 885, 911-913, 922  
adaptation options, 836, 845, 846  
change, 1114  
climate-resilient pathways and, 1114, 1120-1121  
development, transfer, and diffusion, 885  
information and communication technologies, 884  
socio-technical transformation, 1105, 1120-1121  
transfer, 966
- Telecommunication**, 538, 558-559, 571, 572
- Temperature**  
annual averaged surface temperature, 139  
conclusions of AR4, 189  
early warning systems, 52, 734, 872, 876, 878, 883-885, 1145, 1466, 1538  
extremes, 189, 720, 1162, 1165-1170  
Giorgi-Francisco regimes, 1160  
global averaged (1880-2012), 1137  
global mean surface, 4, 178, 179  
hottest months (1980-2009), 732  
human thermoregulation, 713, 720-721

- interactive effects, 416  
 nonlinear and threshold effects, 735-736  
 observed changes, 10, 57-58, 81-84, 138, 139, 1153  
 projected changes, 10, 57-58, 81-84, 138, 139, 182, 1153, 1154  
 projected impacts (See Temperature impacts)  
 ranges for plants and animals, 427-428, 427, 428, 429-431, 430  
 RCP projections, 139  
 regional observed and projected changes, 81-84  
 scenarios compared, 178, 179  
 sea surface (SST) (See Sea surface temperature)  
 temperature range for animals, 49  
 thresholds, 63, 713, 735-736  
 tolerance and its limits, 432, 736  
 warm days/nights, 318-319, 554-555, 720, 1163, 1165-1170  
 web bulb global temperature (WBGT), 732, 736  
 See also Heat waves; Temperature impacts; Temperature projections; *specific regions and countries*
- Temperature impacts**, 63, 713, 720-721, 731  
 global/aggregate impacts, 13, 14  
 heat-related deaths, 110, 713, 720-721, 736, 983, 1058, 1069, 1374  
 irreversible impacts, 13, 14, 62  
 key risks and vulnerabilities, 13, 59-60, 1070, 1073, 1074  
 projected impacts of 2-3°C rise, 69-70, 796, 1121  
 projected impacts of 4°C rise, 63, 924, 1123  
 projected impacts of greater than 4°C rise, 1062-1064  
 regional impacts, 1153, 1154, 1158-1159, 1160-1161
- Temperature projections**, 10, 57-58, 1162, 1163-1170  
 extremes, 1162, 1163-1170  
 regional, 1158-1159, 1159, 1160  
 warming to 2°C above pre-industrial, 62, 735  
 warming to beyond 2°C above pre-industrial, 735, 735, 736
- Terrestrial and inland water systems**, 271-359  
 abrupt and irreversible regional-scale changes, 276  
 adaptation and its limits, 277, 321-328  
 adaptation capacity, 277  
 adaptation opportunities, constraints, and limits, 922  
 alien and invasive species, 275, 288-290, 289  
 Amazon basin, 276, 309-310  
 animals, 274, 292, 317  
 biome shifts, 274, 278-279, 279, 280, 281, 316-317  
 boreal-tundra Arctic systems, 276, 292, 303-305, 316-317  
 carbon dioxide and, 287-288, 287  
 carbon sequestration/sink, 15, 64, 67, 275-276, 276, 277, 313-314, 315, 989  
 carbon source, potential to become, 276, 313-314, 315  
 climate change impacts on, 274-277, 301-319, 302  
 detection and attribution, 44-46, 290-291, 291, 989-991  
 disturbance regime, 276, 290, 314, 317  
 dryland ecosystems, 308-312  
 dynamic and inclusive view of, 278-290  
 economic costs of climate change, 326-327, 326  
 emerging issues, 328  
 extinctions, 275, 295, 295, 299-300  
 feedbacks\*, 274, 278, 303-305, 309-310, 315-317, 328  
 forests and woodlands, 301-303  
 freshwater ecosystems, 274-277, 290-321  
 high-altitude ecosystems, 274, 278-279, 279, 312, 317  
 high-latitude ecosystems, 274, 283, 293, 301, 312  
 human-modified systems, 317-319, 364  
 impacts/risks for major systems, 301-319, 302, 1058, 1071  
 key risks, 114  
 land use and cover change, 274, 282, 283-285, 284-285  
 management actions, 277, 324-325, 325  
 methods and models, 279  
 mitigation options, 321  
 multiple stressors, 276, 283-290  
 nitrogen, 276, 285-286  
 observed impacts, 30-32, 44-46, 44-48, 274-277, 290-321, 989-991  
 ozone, 286-287  
 paleoecological evidence, 279-282  
 past assessments, 278  
 permafrost, 304, 314-315, 315  
 phenology, 291-292, 321-322, 989  
 plants, 291-292  
 productivity, 276, 286, 292-293  
 projected changes, 274-277, 290-321  
 radiation, 14-16, 288  
 spatially restricted populations, 275  
 species distribution and movements, 274-275, 294-299  
 tipping points, 276, 278-279, 301, 309-310, 316-317  
 tree mortality, 15, 276, 306-307, 308  
 uncertainties, 278, 279, 328  
 vulnerability/risk, 274-277, 290-321, 302
- Terrestrial ecosystems**, 271-359  
 adaptation, 277, 321-328  
 biodiversity, 274  
 carbon sequestration/sink, 15, 64, 67, 275-276, 277, 313-314, 315, 989  
 carbon source, potential to become, 276, 313-314, 315  
 carbon stocks, 293-294  
 detection and attribution, 982, 983, 989-990, 1005-1006, 1017  
 extinctions and invasions, 14-15, 275, 288-290, 289, 295, 295, 299-300  
 feedbacks, 274  
 forest dieback, 15, 66, 276, 306-307, 1016  
 genetic and evolutionary responses, 322-323  
 land use and land use change, 274, 276, 282, 283-285, 284-285  
 management of, 277, 324-325, 325  
 observed changes, 7, 30-32, 274-277, 982, 983, 989-990, 1005-1006, 1017  
 phenology, 274, 291-292, 321-322  
 in polar regions, 314-317  
 projected changes, 14-16, 274-277  
 species community changes, 274  
 species distribution/abundance, 4, 274, 293-299, 297  
 vulnerability/risk, 274-277, 290-321, 302, 1071
- Thames Estuary 2100 plan**, 365, 389
- Thermal power**, 665-667, 1282  
 extreme events and, 666  
 water resources and, 252, 662, 665
- Thermal sensitivity**, 48, 49  
 in oceans, 48, 414, 431-432, 432, 446
- Thermal stratification**, 80, 1672, 1710
- Thermal stress**  
 hypoxia and, 447  
 in Ocean regions, 1669  
 See also Heat stress
- Thermal tolerance**, 432  
 human limits to, 736
- Thermal windows/ranges**, 49, 427-428, 427, 428  
 upper limits of, 450
- Thermokarst**, 305, 317, 988
- Thermoregulation, human**, 713, 720-721
- Third Assessment Report**, 175, 176
- Thresholds**, 63, 278-279, 1078-1080  
 avoiding, 1084  
 climate, 736  
 critical, 1045  
 critical, livelihoods and, 798, 804  
 critical, poverty and, 807-809, 812-813  
 critical, risk of crossing, 1045  
 detection and prediction of, 278  
 ecosystems, 278-279  
 temperature, 63, 713, 735-736  
 types of, 278  
 See also Tipping points
- Tick-borne diseases**, 722, 723, 725  
 Lyme disease, 723, 725, 736  
 observed changes, 1000  
 tick-borne encephalitis (TBE), 723, 725, 736, 1000
- Ticks**  
*Ixodes* spp., 725  
 thermal tolerance of, 736
- Tidal power**, 1660
- Tipping points\***, 15, 67, 276, 278-279, 301, 902, 1045, 1078-1080  
 Amazon basin, 64, 276, 309-310, 1016  
 Arctic region, 276, 1015-1016  
 avoiding, 1045, 1084, 1085  
 boreal-tundra Arctic systems, 64, 276, 316-317, 1016  
 mitigation and adaptation and, 925  
 risk of crossing, 1045  
 temperature impacts, irreversible, 13, 14, 63  
 temperature impacts, irreversible, 13, 14, 63
- Top-down approaches**, 851, 871-872, 1144, 1144
- Tourism**, 71, 678-679, 693  
 beach tourism, 71, 663, 679  
 climate sensitivity of, 998  
 coastal area impacts, 364, 384-385, 663  
 demand for, 677-679  
 in Europe, 253, 384-385, 679, 1271, 1283  
 global GDP, 1704  
 higher altitudes and latitudes, 663, 678  
 impacts on, 662, 678-679  
 marine, 1704-1705  
 market impacts, 679, 689  
 nature tourism, 663, 679  
 in North America, 636, 1471-1472  
 observed changes, 253, 998  
 planned adaptation, 636  
 projected changes, 71, 253, 633  
 in rural areas, 633, 636  
 ski resorts, 71, 636, 663, 678, 679, 693, 998  
 in small islands, 1623-1624, 1627, 1638  
 summer, 693

- supply, 679  
valuation of, 633  
winter, 636, 693, 998
- Trade**, 70, 1171-1175  
adaptation and, 629  
agreements, 1353, 1448, 1450  
agricultural products, 617, 628-629  
international, 617, 629, 1171, 1173-1175  
regional information, 1171-1175  
rural areas and, 70, 616, 617, 623, 628-629  
sensitivity to climate, 1173-1175  
volumes, 617, 629
- Trade-offs**, 208-209, 216, 217, 394, 925, 1118-1119  
adaptation, 948, 1104  
adaptation and mitigation, 1104  
in adaptation of food production systems, 489  
adaptation options, 918  
costs of, 327  
between economic and environmental goals, 1118-1119  
frameworks for addressing, 1118-1119  
multi-metric valuation and, 1118-1119  
in terrestrial ecosystem management, 325, 327
- Traditional ecological knowledge (TEK)**, 1001
- Traditional knowledge\***, 629, 758, 765-766, 766, 1001  
adaptation experience, 53  
in polar regions, 8, 1583-1584
- Transaction costs**, 955
- Transboundary adaptation**, 1355, 1448-1449
- Transboundary impacts and risks**, 1042-1043, 1059-1062, 1062  
in Australasia, 91  
for small islands, 1616, 1629-1634
- Transboundary pollution**, 1353
- Transboundary water basins**, 776
- Transformation\***, 29, 86, 88, 181, 1105  
definition of, 40, 1122  
spheres of, 86, 1122, 1122  
transformational changes, 1107, 1116, 1121-1122  
in urban areas, 538
- Transformational adaptation**, 89, 181, 513, 1121-1122  
decision making and, 198, 217-218  
definition of, 733  
elements and potentials, 1121-1122  
incremental adaptation vs., 1121  
limits and, 89, 921-922  
need for, 836, 839, 1105, 1106, 1116, 1374  
policy, 1116  
resilience and, 88, 1105  
risk reduction, 1121-1122  
transformative responses, 1106, 1119-1120  
in urban areas, 539
- Transpiration**. See *Evapotranspiration*
- Transportation**, 674-676, 693  
active transport, 714, 742  
adaptation, 571-572  
air, 676  
Arctic sea ice loss and, 559, 776  
bridges, 675  
coastal areas, 383-384  
disaster response, 559  
of energy, 668-669  
extreme weather events and, 559  
geographic zones for impacts, 674  
infrastructure, 628, 662, 674  
inland navigation, 675-676  
navigation and shipping, 559, 776, 776, 1173, 1174, 1584, 1591-1593, 1591, 1592, 1705  
ocean systems and, 453  
pipelines, 675  
in polar regions, 1173, 1174, 1584, 1591-1593, 1591, 1592  
ports, 557, 558, 572, 675-676  
rail, 572, 675  
roads, 572, 674-675, 1467  
in rural areas, 628  
in urban areas, 538, 558-559, 571-572  
vulnerability, 383
- Tree growth**, 293, 303, 308
- Tree line\***, 317
- Tree mortality**, 15, 110, 276, 306-307  
in North America, 1443, 1447, 1459  
observed changes, 276, 308, 991
- Tree rings**, 293
- Triple-win approaches**, 24, 27, 1111, 1117
- Tropical beverage crops**, 625, 626-627, 641, 1528
- Tropical cyclones\***, 147-148, 190, 368, 1707-1708  
in Asia, 147-148, 148, 1333-1334  
in Australasia, 1374, 1377, 1381  
cross-chapter box, 147-148  
impacts, 147-148  
in North America, 1452-1454, 1460, 1477  
observed changes, 621  
projected changes, 147, 370  
in small islands, 1616, 1632  
See also *Extra-tropical cyclones*
- Tropical forests**, 284, 307-308  
See also *Amazon region*
- Troposphere\***, **ozone in**, 286-287, 488, 493, 728-729  
health effects, 716, 728-729
- Tsunamis\***, 390
- Tundra\***, 314-317  
biome shift, 316-317  
fire disturbance, 314, 317  
food webs, 1016  
livelihoods, 1349  
permafrost degradation, 314, 1016  
projected changes, 314, 316-317  
shrub encroachment, 290, 1016
- Turtles, marine**, 414, 448-450, 457
- U**
- Ultraviolet radiation**, 722
- UN Straddling Fish Stocks Agreement (UNSFSA)**, 1713
- Uncertainty\***, 6, 11, 56, 174-176, 175  
communication of, 6, 41, 171  
dealing with in future climate change, 11, 254-255  
decision making and, 9, 56, 198, 207-208, 956-958, 1386-1387  
deep, 254  
risk and, 199  
treatment in this Report, 6, 41, 174-176, 176-177
- Undernutrition**, 490, 713, 805, 810
- Unique and threatened systems**, 12, 61, 983, 1013-1014, 1013, 1044, 1045, 1075-1076
- United Kingdom (UK)**  
adaptation, 1295, 1296  
adaptation costs, 1297  
climate projections, 1276  
coastal policies and adaptation, 365, 388, 389, 395, 1296  
coastal retreat, 389  
critical infrastructure, 1291  
flood defenses, 1157, 1181, 1297  
flood insurance, 885  
floods, 633, 1279, 1280-1281, 1291  
human health, 1291  
insurance, 1283  
London, adaptation risks and potentials, 593-595  
National Adaptation Programme, 880  
river flow, 1279  
sea level, 1276, 1451  
storm surges, 1279  
Thames Estuary 2100 plan, 365, 389  
transportation, 1281-1282  
water quality, 1294
- United Nations Convention on the Law of the Sea (UNCLOS)**, 1661, 1711-1713
- United Nations Framework Convention on Climate Change (UNFCCC)\***, 1042  
Article 2, 1042, 1043, 1047, 1107  
disaster risk management and, 686  
Global Environmental Facility (GEF), 874  
vulnerability assessment, 852
- United States**  
adaptation, 1445, 1446, 1448, 1458, 1466, 1468, 1473-1476  
agriculture, 1446-1447, 1462-1463, 1470  
climate trends, 1443, 1452, 1478  
coastal areas, 1444  
coastal storms, 1444, 1467  
droughts, 999, 1459, 1460-1461, 1470, 1478  
elderly population, 1449, 1451, 1452  
ethanol industry, 1110  
extreme events, 1450, 1470  
fires/wildfires, 1446, 1460-1461  
floods, 1457, 1470  
forest insects, 1446, 1459  
GDP, 1451  
green infrastructure, 884  
human health, 1444, 1447-1448, 1464-1466  
human population, 1448-1449, 1451  
Hurricane Katrina, 211, 381, 383, 810, 1002  
Hurricane Rita, 381  
Hurricane (Superstorm) Sandy, 383, 810, 1466, 1470, 1473  
insurance, 1469  
Mexico-USA border region, 1448-1449, 1470  
migration, 1449-1450  
NAFTA, 1448, 1450  
New York City, 555, 595-596, 884, 1472, 1474  
precipitation, 1443, 1452, 1454, 1456, 1467, 1470  
runoff and streamflow, 1443, 1456  
snow, 1443, 1454, 1456  
socioeconomic indicators, 1451  
temperature, 1443, 1452, 1454, 1456  
temperature extremes, 999, 1443, 1452, 1456, 1464, 1478  
tourism and recreation, 636  
transboundary adaptation, 1448-1449  
transportation infrastructure, 1467  
vulnerability, 1470-1472, 1478  
water resources, 1444, 1446, 1456-1457  
See also *North America*
- Upwelling**, 149-152  
artificial, for geoengineering, 455  
coastal systems and, 364, 373  
cross-chapter box, 149-152



- definition of, 149  
 Eastern Boundary Upwelling Ecosystems, 149, 1659, 1663, 1666  
 Equatorial Upwelling Systems, 149, 1659, 1663, 1666, 1681-1683  
 mechanisms of increasing, 150  
 in ocean systems, 415, 416, 442, 465, 995-996  
 trends in, 149-152
- Urban areas**, 18, 50, 70, 535-612  
 adaptation, 51, 277, 538-540, 563-575, 564  
 adaptation co-benefits, 538, 578-579  
 adaptation constraints, 540, 564-565  
 adaptation context, 549-550  
 adaptation examples, 591-596, 1474  
 adaptation implementation, 539-540, 575-590  
 adaptation opportunities, constraints, and limits, 922  
 adaptation options, economic evaluation of, 962  
 adaptation pathways, 563-566  
 adaptation planning, 215-216, 563-566, 578, 876-877  
 adaptation potentials, 561-562, 591-596  
 adaptation resources, 585-590, 586  
 adaptation support, 539-540  
 adaptive capacity, 179-180, 539, 545, 546  
 agriculture, 539  
 air quality, 556  
 allocating tax shares, 587, 589  
 built environment, 538, 559-560  
 city networks and learning partnerships, 585  
 climate change and variability impacts, 553-556  
 climate-related drivers of impacts, 561-562  
 complexity of, 577  
 conclusions from AR4, 549-550  
 context, 541-547  
 cross-chapter box, 153-155  
 dense nature of, 551  
 development pathways, 563-566  
 differences in, 545  
 direct and indirect impacts, 553-556  
 disaster management assistance, 587-588  
 disaster preparedness, 569  
 disaster risk management, 539  
 disaster risk reduction, 565-566, 565, 588  
 droughts, 538, 552, 555  
 ecological sustainability, 552  
 economic base, 566-568  
 economic development, 567  
 ecosystem-based adaptation, 539  
 ecosystem services, 538, 572-575  
 electric power, 566, 571  
 energy supply, 558, 571  
 as essential to global climate change  
 adaptation, 538  
 extreme heat, 569  
 extreme precipitation, 538  
 extreme weather events, 548, 559, 568  
 financing, 538-539, 540, 586-589, 586  
 flooding, 319, 538, 555-556, 557-558, 804, 962  
 food and biomass, 568  
 food security, 539  
 government/governance, 538-540, 566, 575-578, 576  
 green and white roofs, 574-575  
 green economy, 567  
 green infrastructure, 560, 572-575  
 green spaces, 573-574, 734  
 health and social services, 560  
 heat islands, 59, 551, 554-555, 1070, 1532  
 heat stress, 538, 556  
 heat waves, 558, 575, 1470  
 heritage sites, 560  
 household and community-based adaptation, 580-582, 581, 582  
 housing, 538, 539, 559-560, 568-570  
 human health and disease, 556  
 human population in, 50, 538, 541-547, 544, 553, 554, 622  
 informal settlements, 538, 583  
 infrastructure, 18, 538, 539, 557, 572-575  
 insurance sector, 582-584  
 inter-dependent systems, 538, 549, 556  
 key issues, 541  
 key risks, 114-115, 561-562, 591-596  
 key uncertainties, 550  
 large cities, 541, 542-543  
 leadership, 540, 589-590  
 local government, 566, 577-578  
 low-income groups, 540  
 megacities, 551  
 micro-climate, 538  
 micro-finance for adaptation, 584  
 migration, 563  
 migration from rural areas to, 568  
 peri-urban areas, 153-155, 616  
 philanthropic engagement, 584-585  
 ports, 557, 558, 572  
 private sector engagement, 539-540, 582-584  
 public services, 575  
 railways, 572  
 recreational sites, 560  
 regional differences, 552  
 resilience, 18, 70, 538, 539, 548-549, 550, 560-563  
 risk reduction, 539  
 risks and impacts, 114-115, 550-563, 561-562, 591-596  
 roads, 572  
 sanitation, 538, 557-558  
 scientific evidence base, 540  
 sea level rise and, 538, 555  
 sectors: adaptation, 566-575  
 sectors: exposure and sensitivity, 556-560  
 severity of projected impacts, 796  
 social safety nets, 539  
 spatial and temporal dimensions, 551-552  
 stakeholder involvement, 580-585  
 storm surges, 538, 555  
 stormwater costs, 673  
 sustainability, 560-563  
 sustainable development, 70, 538-539  
 telecommunications, 538, 558-559, 571, 572  
 temperature, 552-555, 553-554  
 transformative adaptation, 539  
 transformative development, 538  
 transportation, 538, 558-559, 571-572  
 uncertainties in climate projections, 540, 563, 580  
 urban effect, 551  
 urban processes, 550-563  
 urban-rural interactions, 153-155  
 vulnerabilities and risks, 65, 538-540, 547-549, 549  
 vulnerability and risk assessment, 579-580  
 warm days/nights, 318-319, 554-555  
 waste economy, 567  
 wastewater, 557-558, 570, 571, 673  
 water-related services, 252-253, 570, 673  
 water supply, 65, 557-558, 570, 673
- Urban ecosystems**, 318-319, 538-539  
**Urban governance**, 538-539, 538-540, 566, 575-578, 576  
**Urban heat islands\***, 59, 551, 554-555, 1070, 1532  
**Urban-rural interactions**, 153-155  
**Urbanization**, 50, 542, 551-552, 1470-1471  
 in Africa, 1224-1225  
 in Asia, 1330
- V**
- Vaccinations**, 21, 714, 733  
**Valuation of impacts**, 617, 630-633, 632  
**Variability, modes of**, 1162, 1180  
**Vector-borne diseases**, 385, 713, 722-726  
 chikungunya fever, 723, 725  
 dengue fever, 723-725, 723, 724  
 early warning systems, 734  
 hemorrhagic fever with renal syndrome (HFRS), 725  
 Japanese encephalitis, 725  
 Lyme disease, 723, 725  
 malaria, 722-723, 723, 1000  
 near-term future, 725-726  
 plague, 723, 725, 1000  
 thermal tolerance of vectors, 736  
 tick-borne encephalitis (TBE), 723, 725  
 See also Diseases; specific diseases
- Vegetation**, 157-161  
 active role in water flows, 157-161  
 Arctic region, 1578-1580, 1579  
 carbon dioxide effects on, 276, 292-293, 303, 308  
 models, 282  
 Normalized Difference Vegetation Index (NDVI), 293, 1578, 1579  
 See also Plants; specific systems and regions
- Venice Lagoon project**, 365
- Vibrios**, 726  
*Vibrio cholerae*, 455, 726
- Vietnam**, 1355  
 adaptation in, 1110-1111  
 coastal population, 373  
 dams in, 1110-1111, 1355  
 exposure to storm damages, 1638  
 gender and inequalities, 809  
 iliving with floods program, 640  
 Mekong River/delta, 640, 803, 1355  
 risk management in Ho Chi Minh City, 958  
 transboundary adaptation planning, 1355
- Violence and conflict**, 8, 20, 39, 50, 65, 72, 732-733, 771-775  
 armed conflict, 771-773, 772  
 climate change as cause of, 771-773, 772, 773  
 climate policies and, 617  
 climate variability and, 1001-1002  
 conflict over resources, 617  
 in Darfur, 773  
 geoengineering and, 776-777  
 geopolitical rivalry, 775-777  
 human health effects, 732-733  
 human security and, 758, 771-775, 772, 773  
 peace-building activities, 775  
 risks of, 1042, 1060-1061  
 sensitivity to climate change, 758  
 vulnerabilities for human populations, 758  
 water scarcity and, 253
- Vitamin D**, 722  
**Voluntary carbon offset (VCO)**, 814

- Vulnerabilities\***, 3, 4-8, 26  
 assessment (See Vulnerability assessment)  
 coastal systems, 364, 372-386, 462-463  
 conclusions of AR4, 182-184  
 definition of, 39, 839-840, 1048-1049  
 drivers of, 633-634  
 ecosystems, 274  
 exposure (See Exposure)  
 freshwater resources, 248-253, 250, 274  
 gender and, 635, 644, 718  
 human health, 717-720, 733-734  
 indicators, 1137, 1177  
 induced vulnerability, 637  
 interactions, 3, 37, 1046  
 key\*, 1039-1099  
 measurement and metrics, 854-855  
 multidimensional, 47-48, 809-810, 809  
 multiple stressors and, 179-180  
 ocean systems, 414-416, 461-465, 462-463  
 reducing, 1045  
 reduction in present, as first step to adaptation, 25-26, 85  
 regional context, 1147-1152  
 risk and, 1050  
 rural areas, 633-637  
 terrestrial and freshwater ecosystems, 274-277, 290-321, 302  
 trade and financial flows and, 1173  
 urban areas, 538-540, 547-549  
 violence and, 733, 758  
 vulnerability mapping, 733-734, 1151, 1152  
 See also Key vulnerabilities; Risk; *specific systems and countries*
- Vulnerability assessment**, 1144, 1144, 1176-1184  
 analysis and reliability of, 1176-1184  
 baseline and scenario information, 1179-1184  
 comprehensive, 840  
 methods, 1144  
 Reasons for Concern, 12, 61, 983, 1013-1016, 1073-1080  
 regional, 1176-1184  
 in rural areas, 619-637  
 scale in, 1149, 1151-1152  
 top-down and bottom-up approaches, 1144, 1144  
 in urban areas, 579-580
- Vulnerability hotspots**, 20, 1137, 1177-1178, 1463
- W**
- Walker Circulation**, 1180, 1671
- Warming**. See *Temperature entries*
- Waste economy**, 567
- Wastewater**, 673  
 adaptation, 570  
 management, 571  
 sanitation and urban drainage, 252-253, 538, 557-558  
 treatment, 257  
 in urban areas, 557-558, 570, 571
- Water**, 672-674  
 adaptation options, economic evaluation of, 962  
 competition for, 232  
 cross-chapter boxes, 157-166  
 groundwater (See Groundwater)  
 surface water, 66, 232, 233, 250-251  
 water-energy/feed/fiber nexus, 92-93, 163-166  
 water-saving techniques, 27, 1116  
 water services sector, 672-674  
 See also Freshwater resources; Hydrological systems
- Water-borne diseases**, 713, 726-727
- Water cycle\***, 157-161  
 climate models of, 235-236
- Water demand/use**, 251-253, 312  
 for biofuel production, 630
- Water flows, vegetation and**, 157-161
- Water infrastructure**, 672-673, 693
- Water management**, 66, 90, 674  
 adaptation, 254, 255, 256  
 adaptation trade-offs, 918  
 adaptive approaches to, 215, 233, 254-255, 255  
 climate change impacts on, 234  
 emergent risks, 1042, 1054-1056, 1056  
 impact on mitigation, 258  
 Integrated Water Resource Management, 254, 877  
 modification of, 253  
 water allocation, 674
- Water quality**, 232, 251, 714  
 drinking water, 232  
 observed changes, 237, 238  
 projected changes, 246, 252, 319
- Water resources**  
 adaptation costs, 256  
 adaptation options, economic evaluation of, 962  
 adaptation potential, 14, 256  
 adaptation trade-offs, 918  
 availability of, 248-251, 251  
 climate change and, 232, 234, 257  
 competition for, 630  
 conservation of, 91  
 detection and attribution, 982, 986-989, 987  
 economic impacts of climate change, 672-673  
 observed impacts, 4, 7, 982, 987-988  
 projected impacts, 14  
 regional water balance, 988  
 resource pricing, 964-965  
 in rural areas, 616, 625, 632-633  
 vulnerability/risk, 248-253, 250  
 See also Freshwater resources; Runoff
- Water scarcity**, 248, 249, 253  
 in Asia, 1330, 1337-1338, 1338  
 human security and, 761-762, 761  
 in urban areas, 555
- Water security**, 248-251
- Water services**, 672-674  
 infrastructure and economy-wide impacts, 672-673  
 inland navigation, 675-676  
 irrigation, 673-674  
 municipal and industrial water supply, 673  
 nature conservation, 674  
 recreation and tourism, 674  
 wastewater and urban stormwater, 673  
 water management and allocation, 674
- Water stress**  
 in Africa, 73-74, 1202, 1217, 1237, 1237  
 in Asia, 1338  
 livestock and, 502  
 projections, 312-313
- Water supply**, 65, 662  
 adaptation, 570, 638-640, 640  
 for energy production, 92-93, 163, 164, 252, 662  
 future impacts and vulnerabilities, 248-251, 251
- infrastructure, 662, 672  
 municipal and industrial, 673  
 reliability of, 233  
 rural areas, 19, 65, 70, 616, 625, 632-633  
 urban areas, 65, 557-558, 570
- Water use efficiency (WUE)\***, 157-158, 294
- Waves**, 1660, 1671  
 coastal systems, 368, 371  
 conclusions of AR4, 190  
 deep ocean swells, 1616, 1630-1632  
 impact on small islands, 1616, 1630-1632  
 significant wave height\*, 190  
 See also Storm surges
- Web bulb global temperature (WBGT)**, 732, 736
- Weeds**, 488, 500, 506-507
- Welfare**  
 economic welfare, 662, 664  
 ocean ecosystems and, 1698  
 social welfare, 1290-1293, 1299, 1301
- Wetlands**, 312, 992  
 coastal, 91, 373, 377-378  
 projected changes, 313, 314
- Wheat**, 488, 489, 1527, 1528-1529  
 observed impacts, 7, 491, 492, 982  
 projected impacts, 5, 17, 69, 488-489, 505, 509-511, 1285  
 sensitivity to climate change, 505  
 temperature and, 498
- White band disease**, 1634
- Wicked problems**, 200-201, 208, 211, 387
- Wildfires**. See *Fires; Forest fires*
- Win-win approaches**, 1111, 1117, 1118
- Wind**, 371  
 coastal systems, 368, 371  
 in Ocean regions, 1658, 1659, 1660, 1671, 1713-1714  
 projects changes, 371  
 surface wind (oceans), 1660, 1671, 1706, 1710  
 wind speeds, 1334  
 wind storms, 276, 1281, 1283
- Wind power**, 327, 630, 666, 668, 1282, 1283, 1660
- Wind turbines**, 327, 668
- Wine production**, 506, 625, 1271-1272, 1292
- Winter mortality**, 721
- Winter tourism and sports**, 636, 693, 998
- Women**. See *Gender*
- Work capacity, heat effects on**, 19, 71, 731, 732
- Working Group I**, 188-191
- Working Group II**  
 core concepts, 3, 3-4, 85  
 Fifth Assessment report (AR5), 3, 3-4, 85, 176-182, 176-177  
 scenarios, 178-179, 179  
 uncertainty, treatment of, 6, 41, 176, 176-177  
 See also IPCC assessment reports
- Working Group III**, 191-192
- World Bank**  
 country development terminology, 181  
 economic estimates, 960  
 Pilot Program on Climate Resilience, 844, 879
- World Economic Forum**, 843
- Y**
- Yellow Sea**, 1686-1687
- Z**
- Zoonoses (zoonotic diseases)**, 725, 726
- Zooplankton**, 431, 440-441, 455
- Zoos**, 326