Index

Index

Agricultural Computer Network (AGNET), 327 Agricultural Statistics, 33 agricultural surpluses, 42 Alaska, 12, 188 All-American Canal, 123 American Heart Association, 93 American Indians, 25, 181, 261 American Medical Association Advisory Panel on Toxic Substances, 98 Appalachian Mountains, 162 Argentina, 265 arid and semiarid lands: alternative agriculture, 322 animals for, 263 basic and applied research, 19 definition of, 30 ground water (see ground water) irrigation (see irrigation land area, 30 natural features of, 351 potential new crops, 258 regions of the United States, 3, 30 vegetation types, 37, 261 Arizona, 30, 35, 38, 39, 41, 56, 66, 75, 90, 119, 120, 121, 123, 129, 130, 132, 134, 135, 138, 157, 161, 201, 263, 283, 386 Arizona Department of Water Resources, 135 Arizona-Sonora Desert Museum, Tucson, Ariz., 322 Arkansas River, 60, 70, 73, 76, 189, 274 Arkansas, White, and Red River Basins, 364 Australia, 156, 266 "Blueprint for a Dryland Democracy," 110 Bonneville Power Administration, 185 Brazil, 265 Brazes River, 75, 204 Bredehoeft, J., 73 California, 30, 31, 33, 34, 35, 37, 38, 39, 41, 56, 60, 70, 73, 74, 75, 76, 79, 87, 89, 99, 116, 121, 123, 130, 132, 134, 151, 156, 157, 161, 182, 263, 273, 282, 283, 307, 325 California Basins, 378 California Joint State-Federal River Forecast Center, 171 California Water Resources Control Board, 86 Canada, 60 carbon dioxide (C0,), 63 Carter administration, 67 Cascade Mountains, 30, 40, 52, 53, 60, 61 Census of Agriculture, 33 Central Arizona Project (CAP), 124, 291, 293 Central Valley Project, Calif., 184, 291, 293, 352 Chile, 266 Cincinnati, Ohio, 97 cloud seeding (see weather modification) Colorado, 30, 33, 35, 37, 38, 39, 56, 74, 75, 119, 120, 121, 123, 129, 130, 131, 132, 156, 157, 160, 161

Colorado-Big Thompson project, 12, 136, 188 Colorado Ground Water Commission, 131 Colorado Plateaus, 382 Colorado Rivers, 60, 62, 63, 66, 70, 71, 73, 76, 85, 124, 188, 274, 383 Colorado River Basin, 228, 370 Colorado River Basin Pilot Project Final Environmental Statement, 158 Colorado River Compact, 66, 120, 123, 124 Columbia Basin Irrigation Project, 131 Columbia Lava Plateau, 382 Columbia River, 60, 76, 79, 120, 134, 172 Columbia River Operation Hydromet Management System (CROHMS), 185 Columbia River Valley, 56 computers and information management: agricultural extension services, 18 data bases, 22 Federal data storage systems, 22 Federal funds, 22 private sector, 22 recordkeeping, 18 Congress: Congressional Budget Office (CBO), 25, 26, 347 General Accounting Office (GAO), 281, 291, 293 Office of Technology Assessment (OTA). 19, 66 Select Committee on Disadvantaged People and Renewable Resources, 25 Senate Select Committee on Water Resources, 67 congressional interest, 3, 18, 19, 20, 21, 22, 23, 24, 25, 26 issues and options: achieving equity in water availability and distribution, 345 impacts of water pricing on the adoption of technology, 346 improving the effectiveness of water-related technologies, 347 need for an interdisciplinary program of basic and applied research, 334 need for a strong Federal role in water quality, 341 need to have reliable ongoing information about renewable natural resources, 335 need to integrate water-related agricultural activities in Government agencies, 21, 337 protecting and maintaining long-term productivity of rain-fed agricultural resources, 343 Cornell University, Department of Agronomy, 91 Dalles Dam, 120 Department of Agriculture (USDA], 7, 20, 26, 33, 47, 69, 97, 261, 338 Agricultural Research Service, 48, 300, 338 Bureau of Agricultural Engineering, 172 Cooperative Extension Service, 328 field research stations, 24

Office of the Secretary, 22, 123, 338 Salinity Laboratory, 280 Secretary John R. Block, 42 Soil Conservation Service (SCS), 48, 81, 172, 173, 182, 230, 253, 300 Department of Commerce, 7, 47, 69 Bureau of the Census, 33 National Oceanic and Atmospheric Administration, 48, 69, 156, 172 National Weather Service, 48, 171, 172, 185 Department of Defense, 7, 47, 69 U.S. Army Corps of Engineers, 48, 172, 182, 185, 188, 189, 190 Department of Energy, 7, 69 Department of the Interior, 7 Bureau of Land Management, 48, 203, 313, 317, 339 Bureau of Reclamation, 48, 120, 131, 156, 172, 182, 185, 194, 228 National Water Data Exchange, 48, 68, 69 National Water Summary, 67 office of Water Policy, 67 Office of Water Research and Technology, 47, 67, 334 U.S. Fish and Wildlife Service, 48, 323 U.S. Forest Service, 48, 161, 163, 339 U.S. Geological Survey, 48, 68, 69, 70, 71, 75, 101, 121, 173, 182, 185, 280, 283, 307, 338 Department of Transportation, 7 Dust Bowl, 35, 42 economic values of Western water, 338-391 Environmental Data Information Service, 69 Environmental Protection Agency, 7, 48, 69, 86, 94, 98, 102, 135 farm marketing, cash receipts, 353 Federal institutions, preparedness, 18, 19 Federal Inter-Agency River Basin Committee, 67 Federal Water-Data Colelction Agencies (table 1], 7 Federal Water Pollution Control Administration, 86 Fort McDowell Indians, 120 Fourth National Groundwater Quality Symposium, 89 future energy demands, 80-81 Galapagos Islands, 266 Gila Desert, 56 Gila River, 77, 98 Great Basin, 75, 76, 374 Great Plains, 24, 30, 31, 33, 35, 37, 38, 40, 41, 53, 54, 80, 256, 259, 301, 351 ground water: artificial recharge, 16, 275, 282, 283, 284 calcium, 16 contamination, 16, 17, 89, 90, 267 definition of, 56 depletion of, 14, 16, 41, 73, 274 development of, 62 dissolved minerals in, 279 effects of overdrafting, 291

energy costs for pumping, 286 improving withdrawal efficiency, 285, 287 increasing supplies, 282 law, 113, 116 magnesium, 16 mining, 6, 16, 73, 77, 81, 136, 274, 292, 293 municipal and industrial use, 17 public health, 17, 23 quality (see water quality) recharge basins, cost of, 283 recharge wells, 283 relationship with surface water, 276 resource regions, 56, 59, 276, 277, 380 seepage, 50, 275 social costs, 17 special characteristics, 290 subsidence, 16, 293 table, 50 technologies affecting, 16, 273 upward capillary movement, 50 use, 273 water spreading, 282 well efficiency, 287, 288, 289 Gulf Coastal Plain, 56 Gulf of Mexico, 50 Hawaii, 30 hazardous waste sites by State, 384 High Plains Associates, 274 High Plains Underground Water Conservation District No. 1, 286 Hoover Dam, 123 hydroelectric generation (see water use) hydrologic cycle, 3, 6, 9, 10, 11, 47, 48, 80, 113, 150, 164, 181, 309 atmospheric moisture, 53 data bases, 7 evaporation, 49, 230 evapotranspiration, 53, 54, 56, 57, 150 human intervention, 66 infiltration, 50, 56 measurement techniques, 64, 65, 66 percolation, 50, 56 plants, 243 precipitation, 49, 52, 53, 54, 56, 57 runoff, 50, 56, 60 soil water, 211 transpiration, 50, 230 variability, 61, 66 watershed, 50, 151, 160, 161 hydrologic zones, 52 Hydrometeorological Streamtlow Prediction (HM), 172, 173 Idaho, 30, 33, 35, 37, 38, 39, 75, 119, 121, 129 Illinois, 97 Interior Basin, 351 International Agency for Research on Cancer, 92 International Boundary and Water Commission, 7, 69 irrigation, 5, 6, 9, 12, 13, 14, 16, 34, 79, 134, 287

acreage, 40 conservation, 230 definition of terms, 229 development in Great Plains, 37 economic values, 174, 388 energy costs, 141, 259, 285, 286 fuels used for, 287 impacts of, 130, 131 methods, 231, 232, 233, 234, 235, 236 onfarm reservoirs, 184, 191, 194 purposes, 38 quality of water, 87, 93 reuse of wastewater, 88, 309 scheduling, 17, 302, 303 social ramifications, 41 system management, 237 training, 195 water distribution procedure, 192, 193, 194 Israel, 18, 304 Kansas, 5, 30, 31, 34, 35, 38, 39, 75, 119 Kings River, Calif., 192 Land Institute, Salina, Kans., 322 land-use management technologies: alternative agriculture, 18, 322, 323 animal mixtures on rangelands, 18, 321 brush management, 319, 320, 321 computers, 327, 328, 329 Federal efforts, 22 fisheries, 314 multiple use of croplands, 324, 325 multiple use on rangelands, 17, 313 nonforage plant products, 315 nonmeat animal products, 315 plants and animals, 317, 319 reclamation, 315, 316, 317 recreation, 315, 325 revenue from hunting and fishing, 325 wildlife, 314, 325 Lathrop, Calif., 99 legislation: Arizona Groundwater Management Act, 386 Boulder Canyon Project Act of 1928, 123 California Limitation Act of 1929, 123 Carey Act of 1894, 110 Clean Water Act, 23, 102, 122, 123, 300, 342 Colorado River Basin Project Act of 1968, 191 Columbia Treaty of 1964, 124 Comprehensive Environmental Response, Compensation, and Liability Act, 102 Desert Land Act of 1877, 109 Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), 97 Federal Land Policy and Management Act of 1976, 153, 339 Federal Reclamation Act, 1902, 67, 111 Federal Water Pollution Control Act of 1972, 122, 300 Homestead Act of 1862, 109, 111 Mexican Water Treaty, 124

Multiple Use, Sustained-Yield Act of 1960, 153, 339 National Environmental Policy Act (Public Law 91-190). 135 Native Latex Commercialization Act of 1978, 263 Plant Variety Protection Act, 1970, 15, 254 Reclamation Safety of Dams Act of 1978, 191 Resource Conservation and Recovery Act (RCRA), 120 Safe Drinking Water Act, 102 Water Resources Development Act of 1976, 275 Water Resources Planning Act of 1965 (Public Law 89-90), 47, 67, 111 Water Resources Research Act of 1964 (Public Law 88-379), 67 Lower Colorado River Basin, 150, 174 method of OTA study, 393 Mexican Water Treaty, 191 Mexico, 123, 124, 263, 267, 310 Miami, Fla, 97 Minnesota, 256 Mississippi River, 50, 60 Missouri River, 12, 53, 61, 70, 71, 73, 76, 77, 97, 149, 188, 189, 274 Missouri River Basin, 362 Montana, 30, 35, 38, 39, 119, 120, 121, 129, 301 Montana River, 60 Montana Water Code, 117 National Academy of Sciences, 87, 97, 99, 261 national agricultural policy, 18 National Agricultural Research and Extension Users Advisory Board, 348 National Cancer Institute, 94 National Center for Atmospheric Research (NCAR), 20, 335 National Center for Water Resources Research, 19, 20, 334 National Conference of State Legislatures, 385 National Drinking Water Advisory Council, 89 National Interim Primary Drinking Water Regulation, 94 National Organic Reconnaissance Survey, 94 National Research Council, 64, 87, 93, 314 National Science Foundation, 258, 261, 335 National Stream Quality Accounting Network (NASQAN), 101, 102 National Water Assessment, 1968 and 1978, 47, 62, 67, 74, 75, 79, 80 National Water Commission, 47, 67, 69, 274 national water policy, 18 Navajo Indian Irrigation Project, 120 Nebraska, 5, 30, 31, 34, 35, 38, 39, 75, 77, 116, 119, 273Nebraska Natural Resources Information System, 69 Negev Desert, 267 Nevada, 5, 30, 31, 33, 35, 38, 39, 73, 119, 120, 121, 129, 156 New Mexico, 30, 35, 38, 39, 74, 75, 90, 116, 119, 121, 123, 129, 130, 319 New Orleans, La., 97

New Zealand, 266 North Dakota, 30, 34, 35, 38, 39, 119, 156, 157, 256 North Platte River, 77, 78 Nuclear Regulatory Commission, 7, 69 Ogallala aquifer, 35, 130, 131, 132, 141, 181, 273, 274, 275, 382 Ohio River, 60 Oklahoma, 30, 35, 38, 39, 119, 156, 319 Olympic Peninsula, 53 Oregon, 30, 33, 35, 37, 38, 39, 56, 60, 79, 119, 120, 122, 161 Organic Gardening and Farming Research Center, Emmaus, Pa., 261 Orme Dam, 120 Ouachita River, 189 Pacific Northwest, 16, 50, 53, 56, 79, 75, 134, 151 Pacific Northwest Basin, 376 Pacific Northwest Water Resources Region, 79 Papago Indians, 170 payment-in-kind (PIK) program, 42 Peru, 266 Plans for Water Data Acquisition by Federal Agencies Through Fiscal year 1983, 48 plants and animals: animal breeding: artificial insemination, 254 buffalo, 263 cattle industry, 256 computerized recordkeeping, 15 embryo storage and transfer, 15, 255 feedlots, 15, 254 "new" animals, 16, 259 programs, 254 rabbits, 263 ruminant farm animals, 15, 254 sheep and goats, 15, 254 biotechnologies: bacterial osmoregulation, 251 genetic diversity, 14, 15 institutional constraints, 14, 247 private sector research, 15, 247 protoplasm fusion, 14, 246, 247, 250 recombinant DNA, 14, 246, 247, 248, 250, 251 tissue culture, 14, 246, 247, 248, 249, 266 drought-resistant plants, 14, 15, 252 germplasm, 15, 254, 257, 258, 267 halophytes, 265 legal barriers, 259, 261 plant breeding: economic yield, 253 micro-organisms, 266 philosophical basis, 251 potential new crops, 257, 258 six steps, 251 sunflowers, 256 water stress, 15, 253 plants for biomass energy, 262 plants for industrial products, 263 salt-tolerant organisms, 264, 265

promising crop candidates: amaranth, 16, 261 buffalo gourd, 16, 258, 262 cowpea, 16, 261, 262 guar, 16, 263 guayule, 16, 258, 263 jojoba, 16, 258, 260, 263 mesquite, 16, 262 milkweed, 16, 259, 263 saltbush, 16, 262 tepary bean, 16, 245, 258, 261 Population Reference Bureau, 129 Powell, John Wesley, 110 President's Scientific Advisory Committee, 98 Project Skywater Programmatic Final Environmental Statement, 158 Puerto Rico, 30 Pyramid Lake Paiutes, 120 rain-fed agricultural resources: congressional interest, 343 conversion of rangeland, 24 cultivating marginal or unsuited lands, 24 dryland and rangeland research, 24 research and development, 24 Reagan administration, 47 Reagan, President Ronald, 67 Red River, 60, 70, 73, 76, 189, 274 research and development (R&D), 3, 24, 174, 328 Resources for the Future, 293 Rhoades, J. D., 228 Rio Grande Basin, 368 Rio Grande River, 60, 70, 73, 76, 124, 274 Rio Grande Valley, 56 Rock Springs District, Wyoming, 203 Rocky Mountains, 56, 77, 81, 151 Rodale Research Center, 322 Sacramento River Forecast Center, 171 San Joaquin Valley, Calif., 40, 294 Seattle, Wash., 97 Sierra Cooperative Pilot Project Environmental Assessment, 158 Sierra Mountains, 52, 60 Six State High Plains-Ogallala Regional Resources, study, 188, 275 Snake River, 60, 61, 75, 273, 283 soil-water relationships: basin tilage, 217 capillary rise, 212 changing soil properties: chemical soil conditioner materials, 225 harvester ants and termites, 226 micro-organisms, 225 mycorrhizae fungi, 226 soil conditioners, 226 contour furrowing, 217 crop considerations, 236 deep plowing, 216 drip irrigation, 234, 236 evapotranspiration, 212

Great Plains, 213 hydrologic cycle, 211, 212 infiltration, 211, 215 irrigated agriculture, 227, 229 irrigation terms, definition of, 229 land leveling, 218, 219 land-shaping practices, 216 leaching, 228 limited irrigation, 236 managing soil cover: crop residues, 220, 223 fallow systems, 219 modification of plant canopies, 225 mulches, 219, 220 plant-barrier systems, 223 saline seeps, 221, 222, 223 mechanical land treatments, 216, 217 movement, 211 onfarm irrigation efficiencies, 232 onfarm salinity management, 229 site conditions, 211 soil salinity, 228, 229 soil textures, 213 sprinkler irrigation, 234, 235 subsurface irrigation, 235, 236 supplies, 211, 213 supplying full water needs to plants, 231 surface irrigation, 232, 233 technologies affecting, 13 application costs, 14 Federal/State restrictions, 14 terraces, 218 use of precipitation, 215 vegetation, 211 South African, 266 South Dakota, 30, 35, 38, 39, 119, 122, 256 South Platte River, 77, 78 Soviet Union, 256 Stegner, Wallace, 110 stream flow: average for major rivers, 60 Colorado River, 66 data, 174 forecasting, 170, 172, 174 spatial pattern, 61 variability, 62, 63 Streamflow Synthesis and Reservoir Regulation (SSARR), 172 surface water (see also ground water): law, 113, 114 monitoring, 101 nonconsumptive use, 79 quality (see water quality: ground water) reuse, 75, 77 runoff, 50, 56, 60, 150 use, 273 watershed management, 159 Tennessee River, 60

Tennessee Valley Authority, 7, 69

Texas, 7, 16, 30, 34, 35, 38, 39, 90, 119, 129, 156, 157, 273, 319 Texas-Gulf Basins, 366 Texas-Gulf region, 7, 60, 70, 76, 81, 294 Texas-Gulf Water Resources Region, 72 Texas Natural Resources Information System, 69 Tulare Basin, California Tijuana River, 124 Umatilla reservation, 120 University of California, Santa Cruz, 322 University of Nebraska, 324 Upper Colorado River Compact, 120, 123 Upper Colorado River Water Resources Region, 72 U.S. Public Health Service, 93 U.S. Supreme Court, 116, 120 U.S. Water Resources Council, 47, 50, 67, 70, 274, 334 Utah, 30, 33, 35, 37, 38, 39, 90, 119, 120, 122, 123, 129, 156, 157, 160 Utah Division of Water Rights, 69 van Schilfgaarde, J., Director, U.S. Salinity Laboratory, 228 Virgin Islands, 30 Wagon Wheel Gap, Colo., 161 Washington, 30, 31, 35, 37, 38, 39, 56, 60, 71, 79, 119, 122, 131 Water Data Storage and Retrieval System, 69 water-management technologies: aquiculture, 312 "Best Management Practices, " 300 computerized agricultural models, 300 conjunctive use of surface and ground water, 17, 309, 311 crop-management model, 301 enclosures for plants and fish, 17, 43, 310, 312 Federal efforts, 17, 22 flexible cropping, 17, 300, 301 in Israel, 304 irrigation scheduling, 17, 302, 303 wastewater; reuse of, 17, 304, 308 treatment, 305, 306, 307, 308 watershed, 175 Water Policies for the Future, report to the President, 1973, 47, 67 water quality: algae "bloom," 87, 91, 92, 94 agricultural chemicals, 8, 16, 86, 95, 97 "black alkali," 88 boron, 88 brine disposal, 12 calcium, 88, 279 chloride, 88, 279 control of toxic and noxious substances, 16 criteria, 86 desalination, 12 dibromochloropropane (DBCP), 87

drinking water, 23, 87, 90, 93, 97, 99, 278 Drinking Water and Health, 87 Federal role, 23 ground water, 16, 23, 274 dissolved materials in, 279 drinking water, 278 effects of human activity, 281 monitoring, 281 salts, 278 technologies to improve, 284 virus contamination, 89 hardness, 279, 280, 281 heat, affects on, 90 high standards, need for, 23 industrial shopping, 23 integrated analysis of contamination, 8 law (see Western water law) magnesium, 88 management practices, 8, 23 mining activities, 315 monitoring and control, 8, 23, 101, 102 pollution, 7, 16, 23, 63, 87 problems, 85, 86 radioactive substances, 90 regulations: best management practices, 123 Federal involvement, 122 point and nonpoint source pollution, 122 riparian zones, 13 salinity level for livestock, 87 salts, 8, 16, 85, 86, 87, 88, 93, 130, 187, 278 sodium, 88, 93, 279, 281 Sodium Absorption Ratio (SAR) index, 280 sulfate, 88, 279 suspended and dissolved solids, 85 trace element tolerances for irrigation waters (table 18), 89 treatment, 8, 9, 22, 94, 305 well water, 8 water-treatment: carbon tetrachloride, 94 carcinogens, animal, 94, 97, 99 carcinogens, human, 92, 94 cyclodiene insecticides, 97, 98 chloroform, 94 epidemiological studies, 94 dioxin, 98 herbicides. 98 maximum contaminant level (MCL), 94 oxygen-demanding wastes, 94 toxic byproduct, 98 trihalomethanes, 94 water resources: agricultural effects on, 91, 92, 93 analyses, 67, 68, 70, 138 climatic fluctuations, 7, 63, 64, 66 competition for, 5, 132, 133 conservation, 6, 9, 11, 12, 13, 25, 191, 215, 230 consumption, 8, 9, 72, 73, 139 data collection, 67, 68, 70

depletion, 5, 35 efficiency of plants and animals, technologies affecting, 14 (see biotechnologies) energy and mining use, 132 estimate of supply, 6, 63, 72, 73 estimating water prices: alternative cost, 139 change in net income, 139 consumer surveys, 139 direct observation of markets, 139 ex post statistical analysis of water-use behavior, 139 Federal data-collection agencies, 69 Federal involvement, 9, 18, 19, 25, 26, 67, 68, 69 Federal, State, and local spending for, 112, 184 ground water (see ground water) habitat maintenance, 6, 22, 79 instream flow, 22, 72 major region of the United States, 67 mountain snowpack, 7, 10, 61, 71, 81, 150, 171 municipal use, 134 offstream uses, 6, 79 planning and management, 19, 67, 138, 387 precipitation, 9, 11, 13, 49, 149, 150, 155, 156, 176, 215 problems in setting water values: annual rental value or future income, 140 changing values during crop production, 140 comparing values in place, form, time, 140 indirect effect from water development, 140 marginal v. total value, 139 measuring quantity, 140 quality (see water quality) regional characteristics, 355 regional interaction, 19 regions of the Western United States (fig. 9), 51 return flow, 8 reuse, 8, 75, 77, 304, 305 scarcity, 137 State initiatives in planning, 385 storage facilities, 11, 62 subregions, 74, 76 surface runoff, 10, 11, 50, 56, 60, 61, 71, 149, 171 measurement, 65 volume in West, 7, 11, 66, 138 water market, 136 water measurement, 64, 65, 66 water value, 138, 139 waste assimilation, 6, 79 weather modifications, 7, 10, 26, 154, 155, 175 Water Resources Scientific Information Center, 69 Water Salinity Control Project, Yuma, Ariz., 124 watershed management, 22, 50, 149, 150 highland, 26, 152 alpine zone, 10, 151, 153, 159 160, 175 montane forest, 10, 151, 153, 159, 160, 175 impacts of management technologies, 151 lowland, 10, 151, 152, 164, 175 research, 161, 166

snowmelt, 159 transition zones, 153 vegetation management, 161, 163, 164 vegetation removal or replacement, 10 water yield, 163 wet and dry years, 62 wilderness values, 10 "Water Quality Criteria," 86 water storage and delivery: automated upstream control, 193 catchments, 168, 169 compartmented reservoirs, 13, 199, 200 dams, 182 delivery of surface water to irrigation users, 12 desalting plants, 188 desalination (see water quality) downstream control systems, 194 environmental effects, 186 evaporation control: mechanical covers, 13, 199, 200 reflective coatings, 13, 199 surface area reductions, 13, 199 surface films, 13, 199 facilities, 11, 169, 182 farm and ranch ponds, 11, 12, 184 Federal role, 11, 186 financing, 184, 186 imports and exports, 189 interbasin transfer, 12, 188 interstate transfer, 190 regulating reservoirs along irrigation canals, 194 reservoirs, 11, 13, 62, 182, 184, 186 rigid surface linings, 197 soil sealants, 197 surplus water, 12 technologies that conserve supplies: flexible delivery systems, 12, 191 seepage and evaporation control, 12, 195, 196 vegetation management, 12 tradeoffs, agricultural and wildlife, 199 vegetation management, 13, 161, 163, 164 aquatic plants, 13, 202, 203, 204, 206 chemical use, 13, 165, 202, 205, 206 mechanical controls, 202, 203 pest control, 205 saltcedar, 204 water use: adoption of technology, 8 agronomic WUE, 244, 246, 252 animals adaptation to limited water supply, 14, 244, 245. 246 beneficial use, 9, 281 biological WUE, 244 conjunctive use of surface and ground water, 17, 309. 311 conservation, 9, 25, 118 decisionmaking, 24 efficiency of, 9, 70 equity, 24 Federal reserved rights doctrine, 25

Federal subsidies, reduction of, 25 fish habitat, 79, 140 forecast models, 11 growing demands, 9 hydroelectric generation, 6, 22, 72, 73, 75, 79, 81, 140, 174, 390 Indian reserved water rights, 25 irrigation (see irrigation) legal system, 8 local economics, 9 market system, 8, 135 nonconsumptive use, 140 off stream consumption by States, 71, 75 per capita consumption, 72 plants (see biotechnologies) recreation, 6, 22, 79, 80, 136, 137, 140, 314 regional patterns, 47 resource protection, 135 States concern, 9 streamflow forecasting, 7, 11, 22 supply/use patterns, 75 user oversight groups, 26 wastewater, reuse of, 17, 304, 305 water-use rights, 8, 24, 25 Western history and development, 109, 110, 111 weather modification: assessment of, 158 cloud seeding, 10, 154, 155, 175 cumulus air masses, 155 cumulus clouds, 156, 175 natural precipitation efficiency, 156 orographic air masses, 155 seedability potential, 157 silver iodide, 155 warm seeding, 155 Western agriculture: agricultural chemicals, 95-99 agronomy, 9 animals (see plants and animals) augmenting water supplies, 9 brush control, 165, 166, 168 Chaparral-dominated rangelands, 167 competition for water, 133 competition with nonagricultural uses, 41 contaminants, 24 conventional crops, 266 corporate farms, 40 crop specialization, 31 dissolved salts, 92 diversity, 29 dryland, 5, 14, 24, 34, 35, 214, 219, 223, 317 High Plains area, 131 major producing areas, 37 "duty of water," 135 economic efficiency and agricultural technology, 141 equity and fairness in decisionmaking, 5, 24 erosion, 17, 163 exports, 29, 34, 354 farm size and ownership, 39

Federal role, 3, 5 federally owned land, 5, 31 hydrology, 9 income, farming and ranching, 5, 31, 39 irrigation (see irrigation) labor: costs, 40 migrant workers, 41 minorities, 41 role of, 40 long-term future, 41 mesquite-dominated rangelands, 168 national context, 31 natural features, 31 Pinyon-Juniper dominated rangelands, 167 products of, 31 public land, 5 livestock grazing, 5 rangeland, 5, 14, 24, 34, 214, 223, 316 animal mixture, 321 brush management, 319 forage, 36 multiple products, 37 vegetation types, 36 related industries, 29, 34 resource base, long-term productivity runoff agriculture, 168 rural economics, 129 sagebrush-dominated rangelands, 166 salt-tolerant crops: algae, 16, 266 bacteria, 16, 267 blue-green algae, 16, 267 development of, 264, 265, 266, 267 schematic of, 36 seed and nursery stock, 29 selected major crops, 33 socioeconomic factors, 125, 127, 128, 129, 130 soil compaction, 17 soil salinization, 14, 264 sustainability, 9

systems approach to decisionmaking, 5 trends, 41 Western water law: appropriation doctrine, 114 "basin of origin" statutes, 114 common law doctrines, 116 correlative rights, 114 doctrine of prior appropriation, 116 doctrines, 9, 116 El Paso v. Reynolds, 116 Interstate and International Agreements, 123 Sporhase, et al., v. Nebraska, 116 State level, 113 summary of, 115 surface and ground water, 113 weather modification, 157 Western water rights: Arizona v. California, 120, 123 atmospheric moisture, 125 contractual arrangements, 117 Federal doctrine, 118 irrigation, 117 permit system, 117 public trustee, 119 quantification, 119, 120 return flow, 117 State officer, 117 transfer of, 117 Western Indian, 119, 120, 121, 122, 132 Winters v. United States, 119 White River, 60, 70, 73, 76, 189, 274 Wild and Scenic Rivers System, 191 World Health Organization (WHO) United Nations, 89 Wyoming, 30, 33, 35, 38, 39, 119, 122, 123, 129, 201, 261 Wyoming Legislature, 117 Yellowstone River, 64, 77, 78 Yuma, Ariz., 187 U.S. GOVERNMENT PRINTING OFFICE: 1983 O - 25-160 : al 3