A
absent markets, 201–202
abstraction
groundwater, 124–125, 129–131
surface water, 134
access to safe drinking-water
and disease burden, 75–76, 84, 88–90
global level of access, 59–61
health benefits, 6–7, 63, 225–226
human right to, 4–6
improvements, 56, 122, 182, see also
small-scale drinking-water interventions
lack of, 5, 6–7, 56–57, 63–64, 70
and livelihoods, 10–11, 60, 66–71
Millennium Development Goals (MDGs), 2–4
in rural areas, 63–66
small communities, 60, 71
and socioeconomic development, 1–4
time saving, 7, 51, 219
water consumption, 70–71
water interventions, 122, 127
water sources, 123, 127
WHO definitions, 5–6
activity costs, 158–161
affordability of water intervention, 42–47
age weight, 190, 191
arsenic, 7, 77, 85, 176
artesian springs and wells, 125

B
baseline, 107–108, 117–118, 194
basic access to water, 5
benefit/cost ratios, 36
conversion of DALYs averted, 221, 222
drinking-water interventions, 218–219, 222–225
dug well example, 228–229, 233
benefits. See estimating costs and benefits;
health benefits; livelihoods benefits;
non-health benefits; time saving
bias, 81, 111–112
brainstorming, 213–214
branch distribution system, 137

C
capital costs, drinking-water interventions, 20, 152–154, 157, 158–161
case-control studies, 86–87
catchment management, 128–129, 131–133
catchment-sensitive farming, 129
CEA. See cost-effectiveness analysis
chemical contamination, 7, 88–90, 176
children, 29–30, 68, 104
see also infant mortality
chlorination, household based, 140, 177, 194–196, 221, 226
chronic disease, 90, 178
cohort studies, 79–80, 87, 169
community training and education, 56–57, 141–142
community water systems, 60
challenges and solutions, 56–59
financing improvements, 40–47
see also small-scale drinking-water interventions
contamination
catchment management, 128–129, 131–133
chemical, 7, 88–90, 176
groundwater, 123, 125, 128–129, 131–133
microbiological, 6–7, 11, 124, 174
rainwater, 124
surface water, 11, 125–126, 133–134
see also household water treatment; water treatment
contingency costs, 154
cost estimation, 184
drinking-water interventions, 156–165, 182–183, 194
for social cost-benefit analysis (SCBA), 26–30, 208, 209–210
cost recovery, 163–165
cost-benefit analysis. See social cost-benefit analysis (SCBA)
cost-effectiveness analysis, 8–9, 10, 181–185
cost estimation, 18–24, 182–183
definition, 8, 40, 41
discounting, 9, 21, 24–25, 26, 186, 187
drinking-water interventions, 24–26, 193–196, 222
generalized, 8–9, 192–196
health interventions, 185–193
method, 185–188
non-health benefits, 192
priority-setting, 48–50, 53
weighting, 186, 190–191
WHO-CHOICE, 8–9, 192–193
cost-effectiveness indicators, 21–26, 184
disability-adjusted life years (DALYs), 181–182, 188–192, 194–196, 221–222
cost-effectiveness ratios, 187–188, 189
costing
activity cost estimation, 158–161
challenges, 151–152
drinking-water interventions, 18–21, 149–163, 182–183
elements, 152–156
method, 152–153
see also estimating costs and benefits
cross-sectional studies, 78–79, 80, 86, 169

D
DALYs. See disability-adjusted life years (DALYs)
dams, 133–134
data
analysis, 117–118
categories, 152
processing, 116–117
deep wells, 125
demographic profiles, 16–17, 211, 213
dendritic distribution system, 137
development assistance, 59
diarrhoea, 6–7, 76–77
cost estimation, 184
cost-effectiveness of water intervention, 22–23, 24, 194
data collection, 78–79, 209–210
definition, 77–78
disease burden, 84
Index

existing studies, 83–84
health-care expenditure, 24
household water treatment, 140, 177
intervention effects, 140, 170–174, 177
mortality and morbidity, 22–23, 94–99, 136
relative risk, 170–174, 175, 194
social cost-benefit analysis (SCBA), 209–210
diarrhoea reduction, 22–23, 177
cost-effectiveness indicator, 25–26
drinking-water interventions, 22–23, 170–174, 177, 194, 225–226
health benefits, 22, 183
livelihood benefits, 22, 28–29
non-health benefits, 183
disability weight, 190
disability-adjusted life years (DALYs)
disease burden measure, 75, 190
valuation, 221–222
discount rate. See internal rate of return
discounting
cost-effectiveness analysis, 9, 21, 24–25, 26, 186, 187
social cost-benefit analysis (SCBA), 31–32, 205, 213, 215, 229
disease burden
chemical contamination, 88–90
diarrhoeal disease, 84
and disability-adjusted life years (DALYs), 75, 190–191
intervention impact, 168
lack of safe drinking-water, 6–7, 75–76, 84, 88–90
musculoskeletal disease, 90
phased interventions, 176–177
and policy interventions, 143–144
see also diarrhoea; epidemiology
Disease Control Priorities Project 188–192
double difference evaluation, 169
drinking-water. See access to safe
drinking-water; small-scale drinking-water interventions
dug wells, 43–44, 129–131
elementary social cost-benefit analysis, 228–233
dysfunctional interviewing, 115–116

E
ecological studies, 86
economic appraisal, 40
economic assessment
cost-effectiveness analysis. See
cost-effectiveness analysis
costing. See costing
definition, 40
drinking-water interventions, 39–40, 47–48, 182–185, 199–200
health benefits, 183–185
least-cost analysis, 40, 41, 47
method, 182–185
need for, 47–48
social cost-benefit analysis. See social
cost-benefit analysis (SCBA)
economic evaluation, 40
education, 7, 29–30, 104
and community training, 56–57, 141–142
environmental risk of disease, 84–90
epidemiology
case definition, 77–78
case-control studies, 86–87
cohort studies, 79–80, 87, 169
cross-sectional studies, 86
ecological studies, 86
estimating disease occurrence, 77–91
extrapolation from previous studies, 83–84
global estimates, 84, 88
intervention studies, 87
local health data, 81–83
measures of disease occurrence, 76–77
noncommunicable disease, 88–90
primary surveys, 78–80
epidemiology (Continued)
randomized controlled trial, 88
risk assessment, 85–86
sampling, 81
specific risk factors, 84–88
see also disease burden
error sources and reduction, 104–107, 116
estimating costs and benefits
activity costs, 158–161
data collection, 209–210
drinking-water interventions, 18–24,
26–30, 149–163, 182–185, 217–220
livelihoods, 211–213
social cost-benefit analysis (SCBA),
time saving, 28–29, 219–220
European Union Water Framework Directive, 128
external diseconomies, 46
externalities, 202

F
field management, 113–116
filtration, 135–136
household, 140, 174, 194, 195
financial cost-benefit analysis, 201
financing
public sector investment, 39–40, 46–47,
217–218
water improvements, 40–47, 217–218,
226
fixed costs, 155–156
future amount, 186

G
generalized cost-effectiveness analysis, 8–9, 192–196
Geographical Information System (GIS), 86, 87
Global Analysis and Assessment of Sanitation and Drinking-water (GLAAS), 59
government intervention, 203
gridiron distribution system, 137–138
groundwater, 123, 124–125, 128–133, 158
groundwater protection zones, 128–129

H
hand-dug wells. See dug wells
handwashing, 177
health benefits
access to safe drinking-water, 6–7, 63,
225–226
diarrhoea reduction, 183
economic assessment, 183–185
reduced mortality and morbidity, 22–23
health impacts
drinking-water interventions, 167–179,
194
multiple interventions, 176–177
vulnerable groups, 178–179
water collection, 66–67
health interventions, 185–193
health-care expenditure, 24
household expenditure, 42–44, 209, 234
livelihoods analysis, 62
household interventions, 139–140, 177
rainwater harvesting, 123–124, 127, 129
see also household water treatment
household water treatment, 139–140, 174,
221, 226
cost-effectiveness analysis, 194–196
diarrhoeal disease, 140, 177
Human Development Report (UNDP 2006),
50–52, 64–66
human right to safe drinking-water, 4–6
human wealth, 17–18, 62, 71

I
immunization programmes, 49, 187–188
impact assessments, 145
imperfect competition, 202–203
improved water sources, 124, 127–128
definitions, 63
global distribution, 60–61
Index

rural areas, 63–66, 94–99
urban areas, 64
incidence of disease, 77
income distribution, 235–236
incremental cost-effectiveness, 187–188
indicator organism counts, 176
infant mortality, 23, 30, 213

reducing, 46, 49–50, 66, 187, 189
valuation, 30, 187, 189, 190
infiltration galleries, 125
intermediate access to water, 5–6
internal rate of return, 31–32, 229–233
international policy, 143
intervention, definition, 185–186
intervention studies, 87, 168–174
interviewers and enumerators, 110, 112, 113–116
irrigation, 211, 220

L
lakes, 126
least-cost analysis, 40, 41, 47
life expectancy, 190–191
livelihood time cost-effectiveness indicator, 26
livelihoods
and access to water, 10–11, 60, 66–71
analysis, 61–63
framework, 61–62, 101–104
social cost-benefit analysis (SCBA), 17–18, 211–213
livelihoods benefits, 9–11, 71
diarrhoea reduction, 22, 28–29
drinking-water interventions, 16–18, 102–103, 211–213
time saving, 22, 25–26
livelihoods investigations
baseline, 107–108, 117–118
bias, 111–112
communicating information, 118–119
data analysis, 117–118
data collection, 17–18, 104–107, 109–110, 113–116
data processing, 116–117
deep issues, 107–108
equity, 107
error sources and reduction, 104–107, 111–112, 116
field management, 113–116
funding agencies and partners, 112–113
interviewers and enumerators, 110, 112, 113–116
measurable variables and indicators, 108
population identification, 111
questionnaires, 105, 108–110, 116
risk factors, 104–119
sampling error, 111–112
testimonials, 105
vested interests, 112–113
local health data, 81–83
local policy, 144
longitudinal prevalence, 76

M
maintenance costs
drinking-water interventions, 20, 154–155, 161–162
groundwater source development, 158
surface water source development, 158–159
water distribution systems, 160
water treatment, 159–160
market evaluation, 201–204, 205–207
market failures, 201–203
MDG. See Millennium Development Goals (MDGs)
meta-analysis, 170–174
meta-regression, 174
microbiological contamination, 6–7, 11, 124, 174
household treatment, 140
Millennium Development Goals (MDGs), 2–4, 12
mortality and morbidity, 22–23, 94–99, 136
most likely scenario, 36–37, 215
multiple barrier principle, 135, 136
multiple interventions, 176–177
musculoskeletal disease, 90

N
national policy, 143–144
natural wealth, 62
negative cost, 192
net present cost, 25
net present value, 9, 25, 30–31, 226
dug well example, 229, 233
no access to water, 5
non-formal economy, 103
non-health benefits
cost-effectiveness analysis, 192
diarrhoea reduction, 183
sanitation improvements, 50–51
water supply improvements, 50–51
noncommunicable disease, 88–90

O
OECD Development Assistance Committee, 59
operational costs
drinking-water interventions, 20, 154–155, 162–163
water distribution systems, 160
water treatment, 159–160
opportunity cost, 102, 104, 235
optimal access to water, 6

P
participatory hygiene and sanitation transformation (PHAST), 141
pathogen removal, 174–176
perfectly competitive market, 202, 205–207
period prevalence, 76
phased interventions, 176–177
PHAST, 141
piped water schemes
affordability, 44–46
costs, 44, 160
distribution systems, 137–138
rural areas, 68, 69–70
time saving, 68
water consumption, 70–71
water treatment, 135–136
point prevalence, 76
point-of-use improvements, 222–225
policy, drinking-water interventions, 226
policy interventions, 142–145
population identification, 111
precautionary principle, 204–205
present value, 186
see also net present value
present value of benefits (PVB), 31
present value of costs (PVC), 31
prevalence of disease, 76
primary data, 16
primary surveys, 78–80
cohort studies, 79–80, 87, 169
cross-sectional studies, 78–79, 80, 86, 169
priority-setting
cost-effectiveness analysis, 48–50, 53
social cost-benefit analysis (SCBA), 51, 53
produced wealth, 62
public goods, 41–42, 202
public sector investment, 39–40, 46–47, 217–218
public sector services, 186–187
public source points. See standpipes
pumping water
costs, 160–161
hand-dug wells, 131
water distribution systems, 137
PVB. See present value of benefits (PVB)
PVB/PVC ratio, 31
PVC. See present value of costs (PVC)

Q
quantitative microbial risk assessment, 85–86, 176
questionnaires
design, 108–110, 116
intervention studies, 170
livelihoods investigations, 105, 108–110, 116

R
rainwater, 122
  contamination, 124
  harvesting, 123–124, 127, 129
randomized controlled trial, 88, 169–170
recurrent costs
  capital costs, 155–156
  drinking-water interventions, 154–156, 157
regional supply, 126
reporting pyramid, 82
reservoirs, 133–134
  contamination, 11, 134
ring distribution system, 138
risk assessment, 85–86, 174–176, 215
risk factors, in livelihoods investigations, 104–119
rivers, 126
rubbish in rubbish out, 106–107
rural areas
  access to safe drinking-water, 63–66
  improved water sources, 63–66, 94–99
  piped water schemes, 68, 69–70, 94–99
  supply interventions, 129–135
  water supply service, 63–66

S
sampling, 81, 111–112
sanitation, 46, 50–51
SCBA. See social cost-benefit analysis (SCBA)
selective primary health care, 48–50
sensitivity testing, 191, 222, 225
  social cost-benefit analysis (SCBA), 33–37, 203, 233
shadow price, 27–28, 102, 104, 234
  social cost-benefit analysis (SCBA), 203, 207
shallow wells, 125
Shattuck report, 1–2
small-scale drinking water systems. See
  community water systems
small-scale drinking-water interventions
  affordability, 42–47
  benefit/cost ratios, 218–219, 222–225
  cost recovery, 163–165
  cost-effectiveness analysis, 24–26, 193–196, 222
  cost-effectiveness indicators, 21–24, 194–195
  costing, 18–21, 149–163, 182–183
dug well example, 228–233
estimating costs and benefits, 18–24, 26–30, 149–163, 182–185, 217–220
financing, 40–47, 217–218, 226
health impacts, 167–179, 194
intervention studies, 168–174
livelihoods benefits, 16–18, 102–103, 211–213
policy, 226
public sector investment, 40, 217–218
time saving, 28–29, 211, 218, 219–220
see also community water systems
small-scale water distribution, 136–139
social conventions, 203
social cost-benefit analysis (SCBA), 9–10, 200–207
benefit/cost ratios, 228–229, 233
calculation, 30–32
causalities, 207
cost estimation, 26–30, 208, 209–210
and decision-makers, 215
definition, 40, 41
social cost-benefit analysis (Continued)

demographic models, 211, 213
demographic profiles, 16–17
discounting, 31–32, 205, 213, 215, 229
drinking-water intervention, 30–32, 208–213, 217–226, 228–233
dug well example, 228–233
environmental factors, 199, 204–205, 214
income distribution, 235–236
internal rate of return, 31–32, 229–233
livelihoods, 17–18, 211–213
market evaluation, 201–204, 205–207
market failures, 201–203
matrix, 207
method, 15–37, 213–215
most likely scenario, 36–37, 215
net present value, 9, 25, 30–31, 226, 229, 233
primary data, 16–17
priority-setting, 51, 53
PVB/PVC ratio, 31
risk analysis, 215
sensitivity testing, 33–37, 203, 233
shadow prices, 203, 207
social justice, 207, 208
time saving, 211
uncertainty, 32
UNDP 2006 Human Development Report, 50–52
valuation, 234–236
willingness to pay, 208
social justice, 207, 208
social wealth, 18, 62
socioeconomic development, 1–4
solar disinfection, 194, 195
source protection
groundwater, 128–129, 130–133
policy interventions, 145
surface water, 133–134
water interventions, 128–129, 130–133
springs, 125, 131
standpipes, 161, 225
sub-Saharan Africa water interventions, 3, 51, 59
benefit/cost ratios, 218, 219, 225
cost-effectiveness analysis, 194–196
surface water, 122–123
abstraction, 134
contamination, 11, 125–126, 133–134
source development costs, 158–159
source protection, 133–134
surveillance programmes, 144–145

T
time saving, 50
access to safe drinking-water, 7, 51, 219
cost-effectiveness, 21–22
drinking-water intervention, 28–29, 211, 218, 219–220
livelihoods benefits, 22, 25–26
piped water supplies, 68
social cost-benefit analysis (SCBA), 211
water collection, 23–24, 67–68
time taken, water collection, 67–69
time valuation, 235
total demand, 162
travel costs, 156

U
uncertainty, social cost-benefit analysis (SCBA), 32
UNDP 2006 Human Development Report, 50–52
unimproved water sources, 63
unit costs, 156–157, 159, 163
upland springs, 125
upland streams, 126
urban areas, improved water sources, 64
V
valuation
disability-adjusted life years (DALYs), 221–222
time, 235
vested interests, 112–113
vulnerable groups, 178–179

W
Walsh & Warren, on selective primary health care, 48–50
water access. See access to safe drinking-water
water collection, 66–69
injury and ill-health, 66–67
time saving, 23–24, 67–68
time taken, 67–69
water consumption, 70–71
water distribution systems, 137–139, 145, 160
water haulage, 138–139, 160
water interventions, 121–145
cost-effectiveness analysis, 193–196
economic assessment, 182–185
education and community training, 141–142
financing, 226
health impacts, 167–179
improved access, 122, 127
improved source, 127–128
phased, 176–177
policy interventions, 142–145
resource and source protection, 128–129
small-scale water distribution, 136–139
socioeconomic evaluation, 12
source protection, 130–133
supply interventions, 129–135
water treatment, 134–136

see also household interventions;
small-scale drinking-water interventions
water quality standards, 144, 145
water safety plans (WSPs), 122, 177
water services
development assistance, 59
household expenditure, 42–44, 209, 234
public sector interventions, 40–47
sanitation, 46, 50–51
water supply improvements, 42–46
water sources, 122–126
access to safe drinking-water, 123, 127
development costs, 158–159
protection, 128–129
regional supply, 126
see also groundwater; rainwater; surface water
water storage, 140, 159
water supply
improvements, 42–46, 50–52, 53
service in rural areas, 63–66
technology, 11
water treatment, 134–136, 145, 159–160
see also contamination; household water treatment
waterborne disease, 6–7
see also diarrhoea
weighting
cost-effectiveness analysis, 186, 190–191
social cost-benefit analysis (SCBA), 33, 200, 205, 215, 235–236
wellhead protection, 128–129
wells
artesian, 125
hand-dug. See dug wells
WHO-CHOICE, 8–9, 192–193
WHO/UNICEF Joint Monitoring Programme, 60, 63–64, 123, 124, 127
willingness to pay, 208, 234
women education, 7
water collection, 66–68, 127
*World Development Report*, 48, 49
World Health Organization (WHO)
diarrhoea definition, 77
water access definitions, 5–6
WHO-CHOICE, 8–9, 192–193
WHO/UNICEF Joint Monitoring Programme, 60, 63–64, 123, 124, 127
worth of water investment, 222–225
WSP. See water safety plans (WSPs)

*Valuing Water, Valuing Livelihoods*