

ENVIRONMENTAL SENSING AND MONITORING TECHNOLOGIES: GLOBAL MARKETS



IAS030C
April 2014

Kevin Gainer
Project Analyst

ISBN: 1-56965-795-5

bcc | Research
Market Forecasting

BCC Research
49 Walnut Park, Building 2
Wellesley, MA 02481 USA
866-285-7215 (toll-free within the USA),
or (+1) 781-489-7301
www.bccresearch.com
information@bccresearch.com

TABLE OF CONTENTS

TOPIC	PAGE NO.
CHAPTER 1 INTRODUCTION	2
PRINCIPAL TRENDS	2
LARGE GLOBAL OPPORTUNITY	2
SCOPE OF STUDY	4
INTENDED AUDIENCE	4
METHODOLOGY	5
INFORMATION SOURCES	5
ANALYST'S CREDENTIALS	5
RELATED BCC RESEARCH REPORTS	5
BCC RESEARCH WEBSITE	6
DISCLAIMER	6
CHAPTER 2 SUMMARY	8
MAJOR FINDINGS	8
KEY FINDINGS OF THIS STUDY	9
<i>SUMMARY TABLE GLOBAL ENVIRONMENTAL SENSOR AND MONITORING BUSINESS BY MARKET CATEGORY, THROUGH 2019 (\$ MILLIONS)</i>	10
<i>SUMMARY FIGURE GLOBAL ENVIRONMENTAL SENSOR AND MONITORING BUSINESS BY MARKET CATEGORY, 2014 AND 2019 (\$ MILLIONS)</i>	10
CHAPTER 3 OVERVIEW	13
TOTAL SENSORS BUSINESS	13
<i>TABLE 1 GLOBAL MARKETS FOR SENSORS IN CONTEXT, KEY MARKET SEGMENTS, THROUGH 2019 (\$ BILLIONS)</i>	13
OVERALL ENVIRONMENT MARKET CONTEXT	14
<i>TABLE 2 U.S. INDUSTRIES WITH THE LARGEST TOTAL ENVIRONMENTAL CAPITAL EXPENDITURES, 2010 (\$ BILLIONS)</i>	14
<i>TABLE 3 U.S. ENVIRONMENTAL MONITORING AND TESTING MARKET BY OPERATING COSTS EXCLUSIVE OF EQUIPMENT PURCHASES, 2010 (\$ MILLIONS)</i>	15
CARBON DIOXIDE EMISSIONS	15
SENSOR MARKET CLASSIFICATION	15
<i>TABLE 4 SENSOR CATEGORIES IN ENVIRONMENTAL MONITORING</i>	17
PHYSICAL SENSOR TECHNOLOGIES	17
<i>TABLE 5 DOMINANT TECHNOLOGIES DEPLOYED FOR PHYSICAL SENSING</i>	18
<i>TABLE 6 NEW TECHNOLOGY REQUIREMENTS FOR PHYSICAL SENSING</i>	18
CHEMICAL SENSOR TECHNOLOGIES	18
BIOLOGICAL SENSOR TECHNOLOGIES	19
<i>TABLE 7 PROMISING BIOLOGICAL SENSOR TECHNOLOGIES</i>	20
ENVIRONMENTAL PRESSURES AS THE KEY DRIVING-FORCE VARIABLE UNDERPINNING THE GROWTH OF THE SENSORS BUSINESS	20
WATER RESOURCES	21
Intelligent Water Infrastructures Initiative	22
EARTH MOVEMENT - WIRELESS DETECTION OF LANDSLIDES	22
OTHER KEY MARKET TRENDS	23
CHAPTER 4 REGULATORY DRIVERS	26
OVERVIEW	26

TOPIC	PAGE NO.
GOVERNMENT ENVIRONMENTAL MONITORING SPENDING TRENDS	26
<i>TABLE 8 BUDGET TREND AT THE EPA, 2008-2013 (\$ MILLIONS)</i>	26
NATIONAL POLAR-ORBITING OPERATIONAL ENVIRONMENTAL SATELLITE SYSTEM	27
CLOUDS AND THE EARTH'S RADIANT ENERGY SYSTEM	28
EPA ENVIRONMENTAL STRICTURES	28
AIR MONITORING	29
CHAPTER 5 ENVIRONMENTAL NETWORKS	31
MARKET OVERVIEW	31
TYPES OF ENVIRONMENTAL NETWORKS	31
NATIONAL AND INTERNATIONAL BIOSURVEILLANCE	32
WATER SECURITY INITIATIVE	32
BIOWATCH PROGRAM	33
BIOLOGICAL COMMON OPERATING PICTURE	33
HIGH-ALTITUDE DEVICES TO DETECT HEALTH THREATS FROM THE SKY	34
<i>TABLE 9 FEDERAL SPENDING ON BIO-SURVEILLANCE NETWORKS, THROUGH 2016 (\$ MILLIONS)</i>	35
LARGE ENVIRONMENTAL MONITORING NETWORKS	35
PLANET LABS INC.	35
SKYBOX IMAGING INC.	35
REMOTE SATELLITE METHODOLOGY FOR EARLY WARNING OF CHOLERA EPIDEMICS	36
OCEAN OBSERVATORIES INITIATIVE	37
INDIAN OCEAN TSUNAMI WARNING SYSTEM	38
QUAKE CATCHER NETWORK	38
FOG WARNING SYSTEMS	39
PACHUBE NETWORKING	40
ARGO	40
FLUXNET	41
HIGH-PERFORMANCE WIRELESS RESEARCH AND EDUCATION NETWORK	41
ZEBRANET	42
AUTOMATED RADIO-TELEMETRY SYSTEM	42
EXTENSIBLE SENSING SYSTEM	42
NATIONAL ECOLOGICAL OBSERVATORY NETWORK	43
GLOBAL LAKE ECOLOGICAL OBSERVATORY NETWORK	43
ATMOSPHERIC RADIATION MEASUREMENT CLIMATE RESEARCH FACILITY	44
DEFENSE WEATHER SATELLITE SYSTEM	44
DELAWARE ENVIRONMENTAL OBSERVING SYSTEM	45
GLACSWEB PROJECT	46
TIDE STATION DATA-SHARING NETWORKS	46
SENSOR MANAGEMENT FOR APPLIED RESEARCH TECHNOLOGIES	47
INTEGRATED SENSOR WEB APPROACH FOR NATURAL HAZARD APPLICATIONS	47
CYBERINFRASTRUCTURE TO ACCESS ENVIRONMENTAL DATA IN RURAL AREAS	47
CITISENSE AIR-QUALITY MONITORING SYSTEM	48
NTT DOCOMO, INC. ENVIRONMENTAL SENSOR NETWORK BUSINESS	49

TOPIC	PAGE NO.
SIEMENS CORPORATE TECHNOLOGY URBAN FLOOD PROJECT	50
AGRICULTURE SENSOR NETWORK APPLICATIONS	50
SOIL MONITORING SYSTEMS	52
CITIZEN SCIENTISTS' NETWORKS	52
DYNAMIC LARGE-SCALE SENSOR NETWORKS	53
OTHER SENSOR NETWORKING INITIATIVES	53
CHAPTER 6 CATEGORIES OF ENVIRONMENTAL SENSORS	55
OVERVIEW	55
ANALOG VERSUS DIGITAL ENVIRONMENTAL SENSORS	55
TYPES OF ENVIRONMENTAL SENSING	56
<i>TABLE 10 ENVIRONMENTAL SENSING TYPES AND COMPANIES INVOLVED, 2013</i>	56
CHAPTER 7 MARKET SEGMENTS IN THE ENVIRONMENTAL SENSOR BUSINESS	59
OVERVIEW	59
<i>TABLE 11 SENSORS USEFUL IN ENVIRONMENTAL DETECTION AND MONITORING</i>	59
SENSORS BY MODALITY	60
<i>TABLE 12 SENSORS BY MODALITY AND RELATIVE COST</i>	60
DISCUSSION OF PRINCIPAL TYPES	61
FLAME IONIZATION DETECTORS	61
IN SITU PERMEABLE FLOW SENSOR	62
LASER-INDUCED FLUORESCENCE	63
METAL OXIDE SEMICONDUCTOR SENSORS	63
PHOTO IONIZATION DETECTOR	64
RIBBON NAPL SAMPLER	64
CATALYTIC BEAD SENSORS	65
ELECTROCHEMICAL SENSORS	65
SURFACE GAMMA RADIATION DETECTION	65
Three-Dimensional GammaModeler	65
RadScan 600 Gamma-Ray Imaging System	66
In Situ Gamma Spectroscopy with an In Situ Object-Counting System	66
INFRARED SENSORS	66
LASER ACOUSTIC SENSOR	67
QUARTZ-ENHANCED PHOTOACOUSTIC ABSORPTION SPECTROSCOPY	67
MICROWAVE RADIOMETER	68
VISIBLE SENSORS	68
ULTRAVIOLET SENSORS	68
RADAR	68
COMBINATION DEVICES	69
MARKET SALES BY TYPE	70
<i>TABLE 13 GLOBAL SALES OF ENVIRONMENTAL SENSORS BY TYPE WITHIN MARKET CATEGORIES, THROUGH 2019 (\$ MILLIONS)</i>	70
CHAPTER 8 INTERNATIONAL MARKETS	73
OVERVIEW	73
U.S. EXPORT POSITION	73
SOUTH KOREAN SENSOR INDUSTRY	73
MARKET DEMAND	74

TOPIC	PAGE NO.
<i>TABLE 14 SENSOR MARKET IN SOUTH KOREA, 2010 (\$ MILLIONS)</i>	75
KEY SUPPLIERS	76
<i>TABLE 15 KEY SENSOR SUPPLIERS IN THE SOUTH KOREAN MARKET</i>	76
SOUTH KOREA'S UBIQUITOUS SENSING PROJECTS	77
Market Demand	78
MARKET ENTRY STRATEGIES	79
TAIWANANESE WIRELESS SENSORS MARKET FOR ENVIRONMENTAL MONITORING AND CONTROL	79
MARKET DEMAND	79
SPECIFIC EXPORT PROSPECTS	80
Agriculture	80
Aquaculture	80
Green Building and Smart Building Technology	81
KEY SUPPLIERS	81
CHINESE MARKET FOR SENSORS AND MONITORING INSTRUMENTS	82
<i>TABLE 16 IN-DEMAND WATER QUALITY MONITORING EQUIPMENT TYPES IN DEMAND IN CHINA</i>	83
CHINESE GOVERNMENT'S ENVIRONMENTAL STRATEGY	83
MARKET DEMAND	84
GOVERNMENT'S ROLE IN ENVIRONMENTAL MONITORING INITIATIVES	85
IMPORTS FROM THE U.S.	86
<i>TABLE 17 PRINCIPAL COUNTRIES OF ORIGIN FOR WATER MONITORING AND SENSORS IMPORTED BY CHINA IN APPROXIMATE RANK, 2008</i>	86
KEY SUPPLIERS TO CHINA'S MARKET	87
<i>TABLE 18 PRINCIPAL FIRMS ACTIVE IN SELLING WATER QUALITY MONITORING TECHNOLOGIES IN CHINA</i>	88
CATEGORIES OF PROSPECTIVE BUYERS	89
MEP	89
China National Environmental Monitoring Center	89
MARKET ISSUES AND OBSTACLES	90
Low-Quality Domestic Equipment	90
World Trade Organization	90
CANADA'S ENVIRONMENTAL INDUSTRY	90
<i>TABLE 19 DISTRIBUTION OF ENVIRONMENTAL REVENUES BY PROVINCE (%)</i>	91
MARKET DEMAND	91
<i>TABLE 20 CANADIAN MARKET FOR WATER FILTRATION AND SEWAGE EQUIPMENT, INCLUDING MONITORING EXPENDITURES, 2008-2011 (\$ MILLIONS)</i>	92
BELGIAN MARKET FOR AIR POLLUTION SENSORS AND MONITORING SYSTEMS	92
MARKET OVERVIEW	93
Brussels-Capital Region	94
Wallonia	94
Flanders	94
MARKET DEMAND AND TRENDS	95
Particulates	95
Indoor Air Quality	95
<i>TABLE 21 MONITORING AND SENSOR EXPORT PROSPECTS FOR BELGIUM</i>	95
COMPETITION AND MARKET ENTRY	96

TOPIC	PAGE NO.
CHAPTER 9 OTHER LARGE SEGMENTS OF THE ENVIRONMENTAL SENSING AND MONITORING BUSINESS	98
OVERVIEW	98
GLOBAL POSITIONING SYSTEMS FOR ENVIRONMENTAL MONITORING	98
GPS INFRASTRUCTURE	98
ENVIRONMENTAL APPLICATIONS OF GPS	99
OTHER GPS SYSTEMS	100
<i>TABLE 22 GLOBAL MARKET DEMAND FOR ENVIRONMENT-RELATED APPLICATIONS OF GPS TECHNOLOGIES, THROUGH 2019 (\$ MILLIONS)</i>	100
RADON MONITORING AND TESTING MARKET	101
<i>TABLE 23 GLOBAL MARKET DEMAND FOR RADON TESTING AND MITIGATION TECHNOLOGIES, THROUGH 2019 (\$ MILLIONS)</i>	102
ENVIRONMENTAL APPLICATIONS OF REMOTE SENSING	102
SCOPE OF APPLICATION	102
RECENT TRENDS	103
PASSIVE VERSUS ACTIVE DATA COLLECTION	104
PRINCIPAL ENVIRONMENTAL APPLICATIONS OF REMOTE SENSING DATA	105
SENSING SYSTEMS BASED ON LARGE-SCALE RADAR SYSTEMS	105
SPACECRAFT AND THE GRAVITY RECOVERY AND CLIMATE EXPERIMENT	107
MARKET DEMAND	108
REMOTE SENSING SOFTWARE MARKET	109
MARKET LEADERS	109
<i>TABLE 24 MARKET DEMAND FOR ENVIRONMENT-RELATED REMOTE SENSING TECHNOLOGIES, THROUGH 2019 (\$ BILLIONS)</i>	110
GOVERNMENT INITIATIVES RELEVANT TO REMOTE SENSING	110
R&D FOCUS	110
<i>TABLE 25 PRINCIPLE ADVANCES EXPECTED IN ENVIRONMENTAL MONITORING ASPECTS OF REMOTE SENSING, 2014-2016</i>	111
<i>TABLE 26 TOP FORECASTED ENVIRONMENTAL MONITORING APPLICATIONS FOR REMOTE SENSING</i>	111
CHAPTER 10 TECHNOLOGY AND PRODUCT DEVELOPMENT	114
OVERVIEW	114
MAJOR TRENDS	114
CYBERINFRASTRUCTURE	114
<i>TABLE 27 NEW SENSOR PRODUCT TECHNOLOGIES AND TECHNOLOGY TRENDS</i>	115
NANOTECHNOLOGY	115
<i>TABLE 28 ECONOMIC ACTIVITY (PRODUCT AND R &D) ATTRIBUTABLE TO NEW ENVIRONMENTAL SENSOR AND MONITORING TECHNOLOGIES, THROUGH 2019 (\$ MILLIONS)</i>	116
CURRENTLY FUNDED SENSOR R&D AND PRODUCT DEVELOPMENT	116
<i>TABLE 29 EXAMPLES OF LARGE SENSOR DEVELOPMENT PROGRAMS, FUNDING AS OF JANUARY, 2014</i>	117
<i>NOTABLE PRODUCT AND TECHNOLOGY FOCUSES</i>	121
ZEOLITES	121
DISTRIBUTED ACOUSTIC SENSING	122
DISPOSABLE, MASS-PRODUCIBLE, NANOPHOTONIC SENSOR CHIPS	122
CITIZEN'S DOSIMETER	123
PLASMONIC SENSORS	124

TOPIC	PAGE NO.
FIELD ASYMMETRIC ION MOBILITY SPECTROSCOPY	124
GAS SENSORS FROM SILICON CARBIDE	125
MOLECULARLY IMPRINTED POLYMERS	126
REAL-TIME MONITORING APPROACHES	126
HEWLETT-PACKARD CENSE INITIATIVE	127
MAGNETOSTRICTIVE BIOSENSORS	128
NANOSENSORS	129
CARBON NANOTUBE SENSORS	129
NANOWIRES AS INEXPENSIVE SENSORS	131
SENSORS FOR HEAVY METAL DETECTION	131
DIODE LASER-BASED SENSORS	132
MILLIHERTZ/TERAHERTZ SENSOR TECHNOLOGY	134
PRINTED AND ORGANIC SENSORS	135
LAB-ON-A-CHIP CONCEPTS	136
WATER VAPOR DETECTION	137
LOW-VOLTAGE CHIPS	138
BIOSENSORS	139
Biosensor Applications in the Field	140
WIND MEASUREMENT SYSTEMS	142
DEVELOPMENTS IN AQUATIC SENSING SYSTEMS	142
SYSTEMS AND NETWORKING APPROACHES	145
Cisco/NASA Sensor Networking Project	145
MASS SPECTROMETRY-BASED DEVICES	146
ACOUSTIC WAVE SENSORS	146
Temperature Sensors	147
Mass Sensors	147
Dew Point and Humidity Sensors	147
Vapor Chemical Sensors: Coated and Uncoated	148
MICRO-ELECTRO-MECHANICAL SYSTEMS SENSORS	148
RADIOISOTOPE SENSORS	149
VOLATILE ORGANIC COMPOUND SENSORS	149
ADVANCED SENSOR COMPUTATIONAL TECHNIQUES	151
ADAPTATION OF SPACE PROGRAM SENSORS FOR TERRESTRIAL USE	151
DISTRIBUTED SENSING FOR ENVIRONMENTAL ROAD CONDITIONS	152
CHAPTER 11 ENVIRONMENTAL SENSORS AND NANOTECHNOLOGY	155
OVERVIEW	155
ENVIRONMENTAL NANOSENSOR MARKET PROSPECTS	156
NANOWIRES	156
PRINCIPAL NANOTECHNOLOGY RESEARCH INITIATIVES INVOLVING SENSING TECHNOLOGIES OR DEVICES FOR POLLUTANT AND MICROBIAL DETECTION	157
NANOGENERATORS	158
HYDROGELS	159
NANOSENSOR FOR THE DETECTION OF SAXITOXIN	159
CONDUCTING POLYMER NANOWIRE IMMUNOSENSOR ARRAYS FOR MICROBIAL PATHOGENS	160
COMPOUND-SPECIFIC IMPRINTED NANOSPHERES FOR OPTICAL SENSING	160

TOPIC	PAGE NO.
NANOMATERIAL-BASED MICROCHIP ASSAYS FOR CONTINUOUS ENVIRONMENTAL MONITORING	161
M-INTEGRATED SENSING SYSTEM BY CONTROLLED ASSEMBLY OF CARBON NANOTUBES ON MEMS STRUCTURES	162
LOW-COST ORGANIC GAS SENSORS ON PLASTIC FOR DISTRIBUTED ENVIRONMENTAL MONITORING	162
SILICON OLFATORY BULB: A NEUROMORPHIC APPROACH TO MOLECULAR SENSING WITH CHEMORECEPTIVE NEURON MOS TRANSISTORS	163
METAL BIOSENSORS: DEVELOPMENT AND ENVIRONMENTAL TESTING	163
ADVANCED NANOSENSORS FOR CONTINUOUS MONITORING OF HEAVY METALS	164
NANOSENSORS FOR DETECTION OF AQUATIC TOXINS	164
ULTRASENSITIVE PATHOGEN QUANTIFICATION IN DRINKING WATER USING HIGHLY PIEZOELECTRIC PMN-PT MICROCANTILEVERS	165
NANOCONTACT SENSOR FOR HEAVY METAL ION DETECTION	165
NANOSTRUCTURED POROUS SILICON AND LUMINESCENT POLYSILOLES AS CHEMICAL SENSORS FOR CARCINOGENIC CHROMIUM (VI) AND ARSENIC (V)	166
MICROFLUIDICS	167
DOLOMITE	167
SANDIA PULSED-DISCHARGE IONIZATION DETECTOR	168
MICROFLUIDICS-BASED LEAD DETECTOR	168
MICROFLUIDIC WATER SENSOR	168
CHAPTER 12 PATENT ANALYSIS	170
<i>TABLE 30 DISTRIBUTION OF ENVIRONMENTAL SENSOR PATENTS BY CATEGORY OF ASSIGNEE, 2009-2013 (%)</i>	170
SAMPLE PATENTS FROM THE U.S. PATENT DATABASE	171
METHOD AND APPARATUS FOR CONTROLLING TEMPERATURE OF AN ACOUSTIC TRANSDUCER	171
Abstract	171
ENVIRONMENTAL MONITORING SYSTEM AND METHOD WITH A PREFILTER	171
Abstract	171
WIRELESS SENSOR SYSTEM FOR ENVIRONMENTAL MONITORING	171
Abstract	172
MULTIPARAMETER SYSTEM FOR ENVIRONMENTAL MONITORING	172
Abstract	172
METHOD AND APPARATUS FOR ENVIRONMENTAL MONITORING AND BIOPROSPECTING	172
Abstract	172
LASER AND ENVIRONMENTAL MONITORING METHOD	173
Abstract	173
ENVIRONMENTAL MONITORING USING MOBILE DEVICES AND NETWORK INFORMATION SERVER	173
Abstract	173
APPARATUS FOR COLLECTING ENVIRONMENTAL DATA AND METHOD OF MONITORING ENVIRONMENT IN REAL TIME	174
Abstract	174
ENVIRONMENTAL SENSOR, PARTICLE COUNTING SYSTEM HAVING AN ENVIRONMENTAL SENSOR, AND METHODS OF OPERATING THE SAME	174
Abstract	174

TOPIC	PAGE NO.
OPTICAL INTEGRATED NANOSPECTROMETER	175
Abstract	175
SENSOR	175
Abstract	175
SYSTEM AND METHOD FOR MONITORING ENVIRONMENTAL CONDITIONS	175
Abstract	176
METHOD FOR INTERNET-WORKED HYBRID WIRELESS INTEGRATED NETWORK SENSORS	176
Abstract	176
WIRELESS SENSOR AND SYSTEM THAT DETERMINES EXPOSURE TO AN ENVIRONMENTAL ELEMENT BASED ON LOCAL CONDITIONS	176
Abstract	177
APPARATUS AND METHOD FOR MEASURING AN ENVIRONMENTAL CONDITION	177
Abstract	177
WIRELESS SENSOR PROBE	177
Abstract	177
MAGNETOSTRICTIVE LIGAND SENSOR	178
Abstract	178
MEASURING DEVICE AND METHOD FOR MEASURING AT LEAST ONE ENVIRONMENTAL PARAMETER	178
Abstract	179
ENVIRONMENTAL SENSOR INCLUDING A BAFFLE	179
Abstract	179
CHARGED CARBON NANOTUBES FOR USE AS SENSORS	179
Abstract	179
ENVIRONMENTAL SENSOR, PARTICLE COUNTING SYSTEM HAVING AN ENVIRONMENTAL SENSOR, AND METHODS OF OPERATING THE SAME	180
Abstract	180
LONG-RANGE, BATTERY POWERED, WIRELESS ENVIRONMENTAL SENSOR INTERFACE DEVICES	180
Abstract	181
SMART FAIMS SENSOR	181
Abstract	181
SIMPLE FIBER OPTIC SEISMOMETER FOR HARSH ENVIRONMENTS	181
Abstract	181
SENSOR AND TRANSMISSION CONTROL CIRCUIT IN ADAPTIVE INTERFACE PACKAGE	182
Abstract	182
SYSTEM AND METHOD FOR REMOTE, FREE-SPACE OPTICAL DETECTION OF POTENTIAL THREAT AGENT	182
Abstract	182
FLUID MOTION AND COMPOSITION ANALYSIS DEVICE AND METHOD	183
Abstract	183
SENSOR APPARATUS	183
Abstract	183
DUAL-CAVITY DISPLACEMENT SENSOR	184
Abstract	184

TOPIC	PAGE NO.
DETECTION AND IDENTIFICATION OF BIOLOGICAL AGENTS USING BRAGG FILTERS	184
Abstract	184
TRUSTED MONITORING SYSTEM AND METHOD	184
Abstract	185
ELECTROCHEMICAL GAS SENSOR	185
Abstract	185
CORRECTION OF HUMIDITY MEASUREMENT RESULTS OF A RADIOSONDE	186
Abstract	186
SYSTEM AND METHOD TO RECORD ENVIRONMENTAL CONDITION ON AN RFID TAG	186
Abstract	186
SYSTEM AND METHOD FOR EFFICIENT AND COLLECTIVE ADJUSTMENT OF SENSOR REPORTING RANGES FOR LONG-LIVED QUERIES	187
Abstract	187
PHOTOLUMINESCENT POLYMETALLOLES AS CHEMICAL SENSORS	187
Abstract	187
SENSING AND ANALYSIS SYSTEM, NETWORK, AND METHOD	188
Abstract	188
IONIZATION-BASED DETECTION	188
Abstract	188
NANO-MECHANIC MICROSENSORS AND METHODS FOR DETECTING TARGET ANALYTES	188
Abstract	189
MICROSCOPIC BATTERIES FOR MEMS SYSTEMS	189
Abstract	189
MEMS-BASED CONDUCTIVITY-TEMPERATURE-DEPTH SENSOR FOR HARSH OCEANIC ENVIRONMENT	189
Abstract	189
METHOD AND WIRELESS COMMUNICATING APPARATUS FOR ANALYSIS OF ENVIRONMENT	189
Abstract	190
SYSTEM AND METHOD FOR TRANSMITTING POLLUTION INFORMATION OVER AN INTEGRATED WIRELESS NETWORK	190
Abstract	190
METHOD OF AND DEVICE FOR DETECTING OIL POLLUTION ON WATER SURFACES	190
Abstract	190
GAN-BASED SENSOR NODES FOR IN SITU DETECTION OF GASES	191
Abstract	191
EMBEDDED PIEZOELECTRIC MICROCANTILEVER SENSORS	191
Abstract	191
MONITORING AN ENVIRONMENT USING A RFID ASSEMBLY	192
Abstract	192
ANALYZER	192
Abstract	192
LASER REMOTE SENSING OF BACKSCATTERED LIGHT FROM A TARGET SAMPLE	192
Abstract	192

TOPIC	PAGE NO.
METHOD FOR SELECTING REPRESENTATIVE ENDMEMBER COMPONENTS FROM SPECTRAL DATA	193
Abstract	193
METHOD FOR INTELLIGENT PARKING/POLLUTION AND SURVEILLANCE CONTROL SYSTEM	193
Abstract	193
IONIZATION SOURCE FOR MASS SPECTROMETER	194
Abstract	194
INTEGRATED NANOTUBE SENSOR	194
Abstract	194
NETWORK OF SENSOR NODES ASSEMBLIES AND METHOD OF REMOTE SENSING WITHIN LIQUID ENVIRONMENTS	195
Abstract	195
INTERSUBBAND SEMICONDUCTOR LASERS WITH ENHANCED SUBBAND DEPOPULATION RATE	195
Abstract	195
SURFACE-PLASMON-RESONANCE SENSING TECHNIQUE USING ELECTRO-OPTIC MODULATION	196
Abstract	196
METHOD FOR COLLECTING AND PROCESSING DATA USING INTERNETWORKED WIRELESS INTEGRATED NETWORK SENSORS (WINS)	196
Abstract	197
CHAPTER 13 COMPANY PROFILES	199
ACREO AB	199
AGILENT TECHNOLOGIES	199
AIRMAR TECHNOLOGY CORPORATION	199
AIRTEST TECHNOLOGIES INC.	200
ALLEGRO MICROSYSTEMS	200
ALERTEK, LLC	200
AMERICAN SENSOR TECHNOLOGIES INC.	200
ANALOG DEVICES, INC.	201
APPLIEDSENSOR, INC.	201
AUTOMATA INC.	202
BALL AEROSPACE AND TECHNOLOGIES CORP.	202
CASELLA MEASUREMENT, LTD.	203
CHELSEA TECHNOLOGIES GROUP, LTD.	203
CIRRUS LOGIC INC.	204
COASTAL ENVIRONMENTAL SYSTEMS INC.	204
CODAR OCEAN SENSORS	204
CROSSBOW TECHNOLOGY, INC.	205
CYMBET CORPORATION	206
CYRANO SCIENCES INC. (A DIVISION OF SMITHS DETECTION)	206
DOLOMITE MICROFLUIDICS	207
DUST NETWORKS INC.	208
ELECTRONIC SENSOR TECHNOLOGY	208
ENDEVCO	208
ENSCO	209
ENVIROMON.NET (A DIVISION OF NETMON)	209

TOPIC	PAGE NO.
EPCOS AG	210
ESI ENVIRONMENTAL SENSORS INC.	210
FLUID COMPONENTS, INTL.	211
FREESCALE SEMICONDUCTOR, INC.	211
GENEFLUIDICS	212
GILL INSTRUMENTS, LTD.	212
HEWLETT-PACKARD	212
HJ SCIENCE & TECHNOLOGY INC.	213
HONEYWELL SENSING AND CONTROL	214
INFICON	214
INFINEON TECHNOLOGIES, INC.	215
INTEGRATED SENSING SYSTEMS INC.	215
INTERNATIONAL SENSOR TECHNOLOGY	216
INTERSIL CORPORATION	216
IROBOT	216
JEWEL INSTRUMENTS	217
KESTREL CORPORATION	217
LANDAUER	218
LINEAR TECHNOLOGY CORPORATION	218
LIQUID ROBOTICS INC.	218
LOS ALAMOS NATIONAL LABORATORY	220
LUMASENSE TECHNOLOGIES INC.	220
MATRIX SENSORS INC.	220
MAXBOTIX, INC.	221
MAXIM INTEGRATED PRODUCTS INC.	221
MEASUREMENT SPECIALTIES INC.	221
MERIDIAN ENVIRONMENTAL TECHNOLOGY INC.	221
MICROCHIP TECHNOLOGY INC.	222
MURATA AMERICAS	222
NASA GODDARD SPACE FLIGHT CENTER	222
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY	223
NATIONAL SEMICONDUCTOR CORPORATION	223
NEXTECH MATERIALS LTD.	223
NXP SEMICONDUCTORS N.V.	224
OCEAN SENSORS INC.	224
OCEANA SENSOR TECHNOLOGY	225
ONSET COMPUTER	226
OPTICAL SCIENTIFIC INC.	226
PACIFIC CREST CORPORATION	227
PALL CORPORATION	227
POTOMAC PHOTONICS	228
PRECISION MEASUREMENT ENGINEERING INC.	228
QUANTITECH, LTD.	228
RENAISSANCE COMPUTING INSTITUTE	229
SANDIA NATIONAL LABORATORIES	229
SATLANTIC INC.	230
SENSATA TECHNOLOGIES INC.	230

TOPIC	PAGE NO.
SENSIRION AG	231
SENSOR PRODUCTS INC.	231
SENSORS INC.	231
SENSORWARE SYSTEMS INC.	232
SENTILLA	232
SIEMENS AG	233
SIERRA MONITOR CORPORATION	233
SIERRA SENSORS GMBH	234
SMART SYSTEM TECHNOLOGY & COMMERCIALIZATION CENTER (STC)	234
STANFORD RESEARCH SYSTEMS INC.	235
STMICROELECTRONICS	235
SUTRON CORPORATION	236
TRANZEO WIRELESS TECHNOLOGIES INC.	236
TRONICS	237
VAISALA INC.	237
WAYNE STATE UNIVERSITY COMPUTER SCIENCE DEPARTMENT	237
WORLDSENSING	238
XENSOR INTEGRATION BV	238
XIVELY	239
YSI INC.	239
ZIGBEE ALLIANCE	239
OTHER SENSOR INDUSTRY ORGANIZATIONS	240
CENTER FOR EMBEDDED NETWORKED SENSING UCLA	240
SENSOR HUB NET	240
CHINA NATIONAL ENVIRONMENTAL MONITORING CENTER	240
CHINESE ASSOCIATION OF ENVIRONMENTAL PROTECTION ADMINISTRATION INDUSTRY	240

LIST OF TABLES

TABLE HEADING	PAGE NO.
SUMMARY TABLE GLOBAL ENVIRONMENTAL SENSOR AND MONITORING BUSINESS BY MARKET CATEGORY, THROUGH 2019 (\$ MILLIONS)	10
TABLE 1 GLOBAL MARKETS FOR SENSORS IN CONTEXT, KEY MARKET SEGMENTS, THROUGH 2019 (\$ BILLIONS)	13
TABLE 2 U.S. INDUSTRIES WITH THE LARGEST TOTAL ENVIRONMENTAL CAPITAL EXPENDITURES, 2010 (\$ BILLIONS)	14
TABLE 3 U.S. ENVIRONMENTAL MONITORING AND TESTING MARKET BY OPERATING COSTS EXCLUSIVE OF EQUIPMENT PURCHASES, 2010 (\$ MILLIONS)	15
TABLE 4 SENSOR CATEGORIES IN ENVIRONMENTAL MONITORING	17
TABLE 5 DOMINANT TECHNOLOGIES DEPLOYED FOR PHYSICAL SENSING	18
TABLE 6 NEW TECHNOLOGY REQUIREMENTS FOR PHYSICAL SENSING	18
TABLE 7 PROMISING BIOLOGICAL SENSOR TECHNOLOGIES	20
TABLE 8 BUDGET TREND AT THE EPA, 2008-2013 (\$ MILLIONS)	26
TABLE 9 FEDERAL SPENDING ON BIO-SURVEILLANCE NETWORKS, THROUGH 2016 (\$ MILLIONS)	35
TABLE 10 ENVIRONMENTAL SENSING TYPES AND COMPANIES INVOLVED, 2013	56
TABLE 11 SENSORS USEFUL IN ENVIRONMENTAL DETECTION AND MONITORING	59
TABLE 12 SENSORS BY MODALITY AND RELATIVE COST	60
TABLE 13 GLOBAL SALES OF ENVIRONMENTAL SENSORS BY TYPE WITHIN MARKET CATEGORIES, THROUGH 2019 (\$ MILLIONS)	70
TABLE 14 SENSOR MARKET IN SOUTH KOREA, 2010 (\$ MILLIONS)	75
TABLE 15 KEY SENSOR SUPPLIERS IN THE SOUTH KOREAN MARKET	76
TABLE 16 IN-DEMAND WATER QUALITY MONITORING EQUIPMENT TYPES IN DEMAND IN CHINA	83
TABLE 17 PRINCIPAL COUNTRIES OF ORIGIN FOR WATER MONITORING AND SENSORS IMPORTED BY CHINA IN APPROXIMATE RANK, 2008	86
TABLE 18 PRINCIPAL FIRMS ACTIVE IN SELLING WATER QUALITY MONITORING TECHNOLOGIES IN CHINA	88
TABLE 19 DISTRIBUTION OF ENVIRONMENTAL REVENUES BY PROVINCE (%)	91
TABLE 20 CANADIAN MARKET FOR WATER FILTRATION AND SEWAGE EQUIPMENT, INCLUDING MONITORING EXPENDITURES, 2008-2011 (\$ MILLIONS)	92
TABLE 21 MONITORING AND SENSOR EXPORT PROSPECTS FOR BELGIUM	95
TABLE 22 GLOBAL MARKET DEMAND FOR ENVIRONMENT-RELATED APPLICATIONS OF GPS TECHNOLOGIES, THROUGH 2019 (\$ MILLIONS)	100
TABLE 23 GLOBAL MARKET DEMAND FOR RADON TESTING AND MITIGATION TECHNOLOGIES, THROUGH 2019 (\$ MILLIONS)	102
TABLE 24 MARKET DEMAND FOR ENVIRONMENT-RELATED REMOTE SENSING TECHNOLOGIES, THROUGH 2019 (\$ BILLIONS)	110
TABLE 25 PRINCIPLE ADVANCES EXPECTED IN ENVIRONMENTAL MONITORING ASPECTS OF REMOTE SENSING, 2014-2016	111
TABLE 26 TOP FORECASTED ENVIRONMENTAL MONITORING APPLICATIONS FOR REMOTE SENSING	111
TABLE 27 NEW SENSOR PRODUCT TECHNOLOGIES AND TECHNOLOGY TRENDS	115
TABLE 28 ECONOMIC ACTIVITY (PRODUCT AND R &D) ATTRIBUTABLE TO NEW ENVIRONMENTAL SENSOR AND MONITORING TECHNOLOGIES, THROUGH 2019 (\$ MILLIONS)	116
TABLE 29 EXAMPLES OF LARGE SENSOR DEVELOPMENT PROGRAMS, FUNDING AS OF JANUARY, 2014	117
TABLE 30 DISTRIBUTION OF ENVIRONMENTAL SENSOR PATENTS BY CATEGORY OF ASSIGNEE, 2009-2013 (%)	170

LIST OF FIGURES

FIGURE TITLE	PAGE NO.
SUMMARY FIGURE GLOBAL ENVIRONMENTAL SENSOR AND MONITORING BUSINESS BY MARKET CATEGORY, 2014 AND 2019 (\$ MILLIONS)	10