

# ' LJLDO P RGHV IRU DVHVLQJ VKH LP SDFW RI DHUMRQ SURFHVVHV RQ UHVHUYRLU DT XDFXOXUH

<DOD9 OGBVDRYQD%#HJGHYD DQG9 OGP LU9\ DFKMDYRMLK2 VP LQ  
ORVFREO\W#BKLQ HFRV\WBS ZVVL D

\$ E V W U D K M L V V R R Q Y J H C H Y L K O Z D W E R U G L V R Q R I W K H  
S U R E O I H P F W D L O A S U R F H V Q V G I V Y B O Q Q L V 7 R K V D U W L F O H  
L G H Q W I S H U R E O M P R F L D M G H V G F L R H [ Q J W F Q Q F H Q I W Q U D W L R Q  
Z D W H O U G I H F W W L B H F R V \ E V W B K W B Z Q W E R U G Q I G O V K H  
V X U U R X D Q G S L D Q J W G H R D P L F F G I H G H Y H O A B S L H G G X F W  
F K D Q J I K V N H R E M H D Q S V R F H M W H D E V O K V I R A N G U X F W X U D O  
D Q D O R E L V H U Y D Q W R O G P Q D W K H P D W M L W D D I D W K F H M D U W  
R I V X F D P R G 7 B D S S O L R D W P E R Q D R V G L R Q H O W J V R B K H  
R E W D L I Q V H G O V R Z I H G H D R N D P R G U H O I O H V F K G H S H I Q G H Q F H  
R I S D U D P B I M F W W L Q H D R I S U R F H V Q I G K V D Q J Q V K M W U D W H V  
D I I F W W L I G H S X O F I W L D R G W K H M R J D J Q L V Q V K H H V H U Y R L U  
. H \ Z R U G W L P X O P W G R I O L Q J V G I F Q D P E R G H F R O R J \  
K \ G U R O S R U R F E K G H V U X H O I L R I G U R V S K H U H

## , Q W U R G X F W L R Q

2 Q H R I V H P R W F U M F D O G F D A U R I Z D M U T X D W L Q D Z D M U E R G L V L W G W R O Y H G R \ J H Q  
F R C F Q A N D R Q O M H O > @ , Q O M U D F R G W R Q R \ J H Q H O M U V V H Z D M U Z L K Z I G G U I Q  
V S O K L Q D G D I L W M R Q R I Z D M U I U R P V X U H V I O Z L Q L Q R V H Z D M U E R G G X H R V H  
S K R A X Q M H V R I D T X D M F S O Q V > @ 7 K H R \ J H Q G P D G R I D Z D M U E R G H R X V M P  
I C F U D H V Z L K V H L Q U H V R I R E M F W W D W H T X L U H V J Q I L F D Q U H R X U H V I R U G F R P S R M Q E  
P I F U R R U D Q L P V I Q V H E R W P Q H U R I Z D M U H J S R O A M G V H Z D J H G X M D O B Q O D H V > @  
' H F R P S R M R Q S U R G X F H V F U E R Q G R I G H R U J D Q F V E V D C F H V O N H D O R K R O D G G E D G V P H O Q  
R U J D Q F D L G / > @ , Q F U D L Q V H H I L F H C F R I V H G F R P S R M R Q S U R F H V E D G G L Q R \ J H Q  
V R V H Z D M U V M R X J K D H U M R Q U G X F H V V H D P R X Q R I Q X M H Q W I R U D O D H E G R P V D G G R Y H O  
U D S G S O Q V U R Z V \$ H U M R Q F D Q P D Q M L Q V H E D D C F H R I E L R U I F D O S U R F H V H V L Q D Z D M U  
E R G I C F U D L Q V H S U R S R U R Q R I I L K U G F L Q V H V H U P D O D G F K P I F D O W M D M F D M R Q R I  
Z D M U F U H M Q F L F X D M R Q I O Z V H F > @

, Q U H T Q V G F D G H V V H I Q M Q I L F D M R Q R I K X P D Q G R P H M F I G G X M I D O D G H F R Q R P I F  
D F W Y L W H K D V V J Q I L F D Q O G L U X S M G O M U D O H R X V M P S U R F H V H \$ X Q I L H G L O M Q H Q W  
G J L D O V V M P L V U H T X L U G V R P R Q V U V H V D M R I H R X V M P V R I Z D M U E R G H V I C F O X G L Q  
D U V L F D O F U H M G R Q V 7 K H I X Q F W R Q D O F D S D E L O M H V R I V F K D V V M P V R X G L F O X G V H  
D E L O W V R S U H G F W K D Q J H V L Q V H F R G W R Q R I D Z D M U E R G I U R P K X P D Q D F W Y L W H  
U F R P P H G D M R Q I R U F R U F W Q S U R E O P V E D H G R Q V H G D U H F L Y H G H J I U R P V Q R V

& R U U H V S R X O V K U R U B A H E O R

Z DMU RU VROVCP SOV LP DJHV RI VMH VXUDFH QD HU RI Z DMU REMFW QFDING DBCQ VMH  
VKRUHQH HAF

%XLCQJ VXF D V VMP UHTXUHV VMH GHYHOSP HQ/RI VLP XDMRQP RG-DV Z KLFK DUH VMH  
GLJLDQV LQ RI VMH UHDOREMFV, Q VMH Z RUNV/RI UH-HDUK-HV VXF P RG-DV UH QFVW TXDQDMYH  
DQG TXDQDMYH FKQDFMUMV/RI DQNH REMFW LQ QH-CFQJ FKQJHV/LQ VMH VDM/RI VMH  
V VMP SURF-HHV> @

7KXV the work aims VR FUJDM DI RUP DOP RG-DG-VFUELOJ VMH FKQJHV/LQ VMH VDM/RI  
SURF-HHV IURP VMH YDQHV RI LQGFDRU/ ) RU VLV SXLSRVH LVLV UHTXUHG VR SHURP VMH  
IROZ LQJ tasks VR HMDQK NH REMFW LQ QH-CFQJ VMH VDM/RI VMH V VMP SURF-HHV VR  
GHMUP LQ TXDQDMYH DQG TXDQDMYH LQGFDRU/RI VMH FKQDFMUMV/RI VXF REMFW VR  
HMDQK VMH UKQV RI LQMDFWRQ RI REMFW DP RQJ VHP VQYH VR HMDQK VMH UKQV RI  
LQ QH-CFH RI H VMDQDIFRUV RQ VMH HMDQK-G REMFW GHYHOSP DP RG-OR VMH V VMP  
EDVGRQ VMH REVQJ-GUH XOV

The object of the study LV FORVH GWSHZ DMUERGHV/The subject of the study LV VMH  
SURF-HHV/DIHFVQJ VMH RQ \ JHQVDMURQ QYHORI Z DMU

The theoretical significance of the study QH/LQ VMH V VMP DQJ DNRQ RI QDMUDAG VR  
VMH QDMURQ RI Z DMUERGHV VMH HMDQK/P HQ/RI NH LQGFDRU/DIHFVQJ VMH VDM/RI VMH  
SURF-HHV DQG VMH FUJDMRQ RI DXQLHG P RG-OXQP ELJXRVO GHVUELOJ DQMH SURF-HHV  
RI VMH DTXDNF HFRX VMP VLVQEH I RU XVH LQ RMDU VMGHV UHONG VR VMH VMDQCEQ  
GHYHOSP HQ/RI VMH VLVQEH/DQGHQYLRQP HQDQD HW

The study's practical significance QH/LQ GHYHOSPQJ D VROMD/P RQVLU/VMH VDM/RI  
VMH Z DMUERG HFRX VMP GHYHOSPQJ UFRP P HQEDNRQ/I RU RUJ DQJ LQJ DQG FDUV LQJ RAV  
Z RUNVMD/P DQDQDEDDCF G VDM/RI VMH Z DMUERG DQG FUJDMRQ SDQJ I RUP XQLSDQMV  
VR VSHQGUH RXUHV/UDNRQDQ

0 D W H U L Q D H W K R G V

7KHVMG RI QDMUDUHV RXUHV/UHONG VR VMH GHYHOSP HQ/RI VLP XDMRQP RG-DV VKRZ HGVMQV  
LVVU UHTXUHG VR I RUP DI RUP DQG VLVQNRQ RI VMH REMFW VMG > @, VMKRXG UH QFV  
DQTXDQDMYH DQG TXDQDMYH FKQDFMUMV/RI VMH GRP DQHP HQV VMH UHDMRQ/DP RQJ  
VHP VQYH DQG VMH UKQV RI LQMDFWRQ ) RU VLV SXLSRVH D VHV P HMRG/ Z DV XVHG  
LQFOXGQJ VXFMDQDQD VLV REMYDNRQ V QMHV DQG P DMH P DMFDQDMV/

7KH V VMP G QDP LEV P HMRG EDVGRQ VMH SUICFSQV/RI VMG LQJ FRP SQJ V VMP V  
Z LVK CRQDQJUIHGEDFN Z DV XVHG VR FUJDM VMH VLP XDMRQP RG-D 7KLV DSSURDFK DV/EHQ  
XVHG LQ VMGHV UHONG VR P RG-DQJ SURF-HHV/UHONG VR DJUFXQMUH HJ LQ GHYHOSPQJ  
VMKQJTXH/IRULQFUDQJ FURS \HQ/> @ HFRQJ HJ LQYHM/DNQ VMH HIFWRI QUERQJ  
FRQF-QDNRQ/RI KQJ IXOXEVMQFH/> @ DQGMHIXCFMRQJ RI FRP SQJ P HMDQV P V>

@&KQDFMUMJ DNRQ RI VMH REMFW DQG VEMFVRI VMH VMG VKRZ HGVMQV VHP RG-DQJ RI VMH  
UHDMQ/SURF-HHV P HW VMH SUICFSQV/RI VMH V VMP G QDP LEV P HMRG RQJ DQG FQEH  
XVGDVDEDV/IRUMH) RUIHVMUP RG-D

5 H V X O W V

7KHVMG RI VMH DSSQDFNRQ RI VMH QDMURQ P HMRG RI Z DMU HV RXUHV/KD/VKRZ QMD/VWV  
XVHG I RU Z DMU VHDV HQ/DQG Z DMU SXULFDNRQ I RU GRP HMF DQG LQGVMDQCHG/ VZ DJH  
Z DMU VHDV HQ/RUJ DV DMURQ RI Z DMUERGHV/RI QDMUDQDQJ DQVFLDORU LQ> @  
7KH DJH/DQMG DUH EURDG DQG UHTXUHG GLIHUHQ/VMKQJTXH/DQGP HQV/RI DSSQJ FQDQJ  
P HMRG/ G-SQJQJ RQ VMH HCG JRQY 3URFHV P RG-DQJ I RU UHMYRUV/ Z LQEH SUH-QMG  
QH W

7KHP DQ SXLSRV HRI VMDH DNRQP HMRG LQDZ DMUERG LV VR SURYLG HFRP SUHK QLYH  
 FDUH IRUJLVZ KFK IRUH DP SOI HOP LQDM VMSRWLEQW RI Z DMUEGRP V FUDM/DFXUHQV  
 IRUH V R \ JHQDNRQ DQG UHG FV VMDH DFXP XDMRQ RI VLOWGG VGLP HQD/VMHERMWP \$ @  
 VLV/KHS VVR FUDMRSWP DQDYLQ FRQGVNRQ/IRUDODTXDNF QH  
 ) LXXH VKRZ V VMDH UHXOV REVLCG E DSSOLQ P HMRG VMDW RUP DQ H VMDH VEMFV  
 GRP DQ DQG FUDM D V P XDMRQ P RG-D , WKRZ V RQD D IUDJP HQ VMDW/VLW D ILK VXLVYDQ  
 P RG-OG-SHQQJ RQP XMSO SUDP HMLV

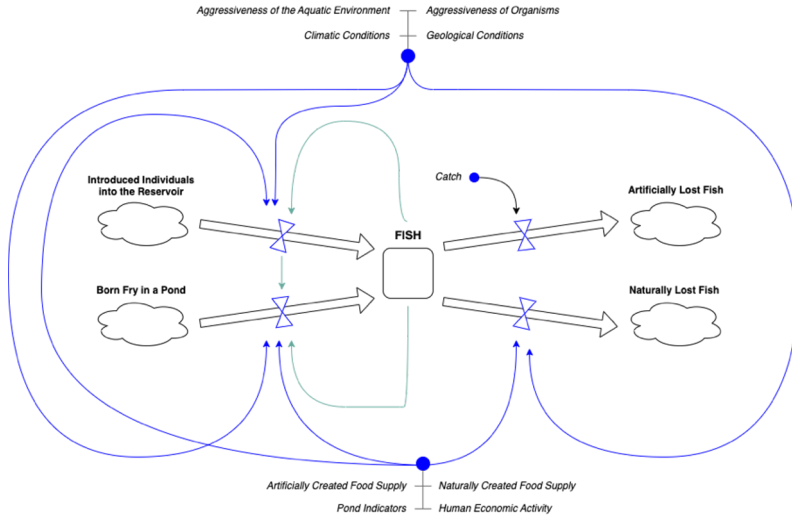


Fig. 1. \$ P R GRM\ V VGH Q D FRUFE WKK U YLQ FDRQ I ZQ HNSRUC V LWQ KDHH U D W L R Q P H W K R G

0 DQ IDFVU/ LQOQH VMDH ILK SRSXDMRQ VMDH DUH VMDP DMFDD JURXSHG IRU  
 V VMDP DMV DNRQ RI SUDP HMLV DQG UHG FVNRQ RI JUDSKF DQG ZLVKRXVGLVVRVNRQ RI  
 UHDMRQV

) LVK FDQ DSSH DULQDZ DMUERG LQVZRZ D V E VRFNLQJ DNDQ JURZ VR VDUH DQGE  
 QDMUDUHSURGXFWNRQ 3RSXDMRQ GFDQH FDQ RFXU GXH VR QDMUDOFDXHV GDMK GXH VR  
 YDUJRV UHDMRQ/ DQG DUVLFDODFXHV ILKIQ 0 DQ LQGFDMU/LQOQH VMDH VSHG RI DQ  
 VMDH SURFHVHV / HXV/SUHVQ/DGHVLSNRQRI DSDUVI VFK LQGFDMU/

) RUDJHEDH/V GYLGGLQR QDMUDODQG DUVLFDQ 1 DMUDQLQFQGHV DQMRVHQXNHQW  
 VMDVHQMDZ DMUERG ZLVKRXVXP DQLQXVIRP FXUHQW ZLQ SUHLSVDMRQ DQDQ DQG  
 RMDH QYLOJ RUDQV VLVQMDH DTXDNF DQGEHQMF Q HUV \$ UWLFDQ HGHUHXUHV/LQFQGHQD  
 VMDH VEMDQHV VMDVXP DQV FRQVEXM GR GRVLCQGH SURGXVRI GRP HMLV RUHFRQP LF  
 DFVYLVHV

( QYLRQP HQDQD JUVHLYHQV/LQFQGHV DQMRVHI DFRU/ VMDVWRUHQ VMDH QH VSDQ RI  
 ILK RUDQGVRI ILK NQY 6XFK IDFRU/LQFQGH IRUH DP SOI VMDH SUHMQH DQGVJ HRI SUHEDRU  
 SRSXDMRQ/ SUDP HMLV DQG VMSRQDMRQ QMHLQDZ DMUERG IURP KXP DQDFVYLVHV \$ VMDH  
 VCP H VPH FOP DMF FRQGVNRQ/ HJ VMDP SHUDMUH VDRQDQW DQG ZDMU ERG  
 FKUDFVMDV V HJ IQZ QMHO JH RULFDQV VMDH QK VQMH QDUHQV QGRXVQV SUDM  
 JURXSV DQMRXJK LQ VMDP VRI PHQQLQ VMDH LQOQH VMDH QMHQRI DJUVHLYHQV RI VMDH  
 HQYLRQP HQV

, QGFDMU/ RI DZ DMUERG LQFQGH D VARI LQGFDMU/ VMDVLCQGHV DQDQW DFLGW  
 GQDQW RGRU/ H/V

7KH XH RI DHDNRQ GLUFDQ D IHFW LQGFDMU/ VMDVLCQGHV Z DMUFRP SRVNRQ DQG VMDH  
 SRQGHQYLRQP HQV/DJUVHLYHQV

### 'LVFXVVL RQ

7KH QDMUHR I VHV VVG UHXQV LV FRP SODEOH VR VWRV HREMLQHG LQ VHV DQDQJHG SDSHU , Q  
 VHP VHV DQVRLV KJKQK VWHNH FKQDFMUMV VR VHV XEIVFVR VVG WADADH FVWH  
 FKQJHRI LV WDM > @7KH IRUP XDMG HQDJHG JURXS VR LQGFRLV/DJHYDQGRU  
 VHV SUREOP GRP DQ DQG DQZ IRU VHV HQDJHG DNRQR VHQDJR VR V VHP UDFWRQ DVLVHQ  
 VPH LQMYDY 7KLV DSSURFK LV LP SOP HQMG LQ ZRUV VR GHYHBS PHQRGRUJLFO  
 UFRP PHQGDNRQ/IRU VHV RSHUDNRQDOP DQJHP HQVR VHV REMFVW WDM VR SUHYHQFUMFDO  
 DQGH PHVHQFLV/RUP LQPLJH GEP DJHURP GLIHQDFVWLVW/DIHFVWQ VHV REMFVR VVG  
 >

@  
 7KH FUDMG PRGHO DQEHXVHG VR FUDM WDLQJ GJLVDOX VMP V XVHG IRUH LP SOD LQ  
 WDLQJ VSHFQJHG ILVHV VSHFQJHG \$ V CRMG LQ VVGHV UHDMG VR GHYHBSQJ DQ  
 LP SOP HQMG GJLVDO RQNRQ/ LQ VHV HGFDNRQD SURFHV LVLV QHFVWQ VR FUDM  
 FROGLRQ/IRU LP SOP HQMG SUDFVH RUIHQMG VDWV WDVH VHV VHV HQDFRQGLRQ/RI D  
 SURLOVSHFQJHG @

### & RQFOXVLRQ

\$ FUMFODSHVRI ZDMUDNRQLVVR LQFUDVWHV \ JHQFRQDQZ KFKLV QHFVWQ IRU  
 VHV UHSLDNRQR P DQ VSHFVRI DQJ WLVV DQGVHGHFRP SRVNRQR RUDQFP DNVLQ  
 VHV ZDMU 7KLV SURYGHV DQK DQ HQVLRQ HQVRLV SODQ DQGRVURJ DQV VVR JURZ  
 DQ UHURGHZ KQVHQFQJ ZDMUHQGLW DQGRV \$ VHV VHP HMP H VHVFRX VMP RI  
 VHV ZDMUERG LVHD LVIRUP HG DQGP DQDQHG DQGVH JHQDHFROJLFO DQNRQDURXGG  
 LVLV LP SURYHG 7KXV RUDQJ LQ FRP IRU DQ DQ IXQNRQDQDQV IRU REVHVYDNRQ DQ  
 HQJ DNRQLVSRMEH

7KH VHVRI GJLVDOX VMP VFDSEOHRI DQDQJ LQ DQJHQXPEHURI KHVRUHQFRXVGDNR  
 GHYHBS HIFVWH P DQJHP HQVGHVNRQ/ DP HG DVLV SURYQJ FHVQ LQGFRLV/ DQ  
 UHQFQJ VHVHQ FHVWHXVRI UHVRUHV VR SUHVYH VHVFRJLFO DQNRQ VHVHQVLRQ HQV  
 LV/DUHQDQV DQRI UHVRU 7KH GHYHBS HQVR VLP XDMRQP RGHVHQDEOH VHV FUDNRQR  
 PHQDQV VVRVFKV VMP V

### 5HIHUH QFHV

' 9 6QRCRY ( 6 \$ QRCRYD : DMU & KHP ( FROJ-3(114)  
 <X\$ ) HGRURY ' 1 \* DQVVD : DMU( FRO 3UREO6RQ(62)  
 + \$ \$ EGHQKP DQ & ( %R G \$ TXDFXO5HV/49(6)  
 7 6XQDQ 0 0 +DTXH 0 \$ 6DQP 0 0 \$ QP - %DQDGHK\$ JUL08 QLY15(1)

; : DQ < 7LQJ ; =KOR 6 3HQJ 4 : X / <DQ %LHV 7HF198  
 0 / RJDQHY 2 . RVRMQ ( 6 : R&460  
 KMSV GRLRJ H VFRQ  
 0 / RJDQHY ' \* RQKQRY %2 : HE & RQ 93  
 KMSV GRLRJ EIRFRQ  
 , 1 . UDQRYD 9 / 6LP RQRY \$ ( 3HMQ %2 : HE & RQ 83  
 KMSV GRLRJ EIRFRQ  
 1 , \* GDQ \$ 9 . DSBRY - 3K V & RQ 6H1515(5)  
 KMSV GRLRJ

0 / RJDFKH 9 6LP RQRY %2 : HE & RQ 83  
KMSV GRLRJ ELFRQ  
1 , \* GQNL \$ 9 . DSR 9 \* 6DP RQRY & KHP 3HWRO ( QJ 47  
KMSV GRLRJ V  
1 , \* GQNL \$ e 3RSRYFK \$ 9 \* RQRY \$ 9 . DSR & KHP 3HWRO ( QJ 55  
KMSV GRLRJ V ]  
\* 6NRXWLV \* 5RGLXJ \* DJFD 6 ) 5HQFNH 8 + DP SHO%RUH 7FK312  
  
( 8JJHW/7 +XJKV5LQ 5 + 0 RUV 0 , 1HZVQ &/ 7UDEL 3 +DZHV -  
\* DJFD 6FL 7RQ QYL559  
\$ . UQRY , 1LNKQD 2 0 XQRYD , . UQRY %2 : HE & RQ 83  
KMSV GRLRJ ELFRQ  
1 , 1LNKQD ( < 5RP DRYD , 1 1LNKQD 9 0 \* UHQRYD 1 \$ YQRYD 0  
' DRYD 0 DW ( GX11(9)